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The Engineer

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The Railway Position.

Small 2-Cylinder Aero-Engine.

PUBLIC NOTICES

SALE BY TENDER.

Tenders are Invited for the PURCHASE, DISMANTLING, and REMOVAL of PLANT (Four Steam-driven Generating Sets with Fittings, &c. &c.), lying at the Post Office Savings Bank, Blythe-road, Kensington, London, W. 14.

Also for the PURCHASE, DISMANTLING, and REMOVAL of PLANT (Boilers, Electric Motors, &c.), lying at the Head Post Office, Liverpool.

Tenders for either or both will be received until 10 a.m. on Thursday, the 22nd March, 1923.

Forms of Tender, containing all particulars, can be obtained on application to the CONTROLLER, Post Office Stores Department, Studd-street Depot, Islington, London, N. 1.

The Postmaster-General does not bind himself to accept the highest or any Tender.

By Order of the
POSTMASTER-GENERAL.

General Post Office,
March, 1923. 1782

Board of Trade.
STANDARDS DEPARTMENT.

A VACANCY exists for an ASSISTANT EXAMINER in the Standards Department of the Board of Trade, with establishment in H.M. Civil Service after two years' approved service. The duties are mainly in connection with the examination of weighing and measuring apparatus of novel types with a view to their approval for use in trade.

Candidates, who must be British subjects by birth and the sons of fathers also British subjects by birth, should possess a University Degree (or its equivalent) in Science or Engineering, and should have had practical workshop experience. Preference will be given to ex-Service men.

The salary is £150, rising by £15 to £300 per annum, with bonus, which is re-assessed half-yearly on the basis of the average cost-of-living figure for the previous six months. The present bonus on £150 is £84 14s., making the total remuneration £744 14s.

Applications, with copies of testimonials, should be made in writing to the PRINCIPAL ESTABLISHMENT OFFICER, Board of Trade, Great George-street, Westminster, S.W. 1, not later than the 17th March, 1923. 1748

H.M.S. "Vernon," Mining DEPARTMENT, PORTSMOUTH.

A VACANCY exists for an ENGINEER, Grade II., to assist an Engineer-in-Charge of design.

Salary £150, rising by annual increments of £10 to £300, and full Civil Service bonus.

Commencing salary, including bonus at present payable, £244.

The bonus is subject to an increase or decrease based on the cost-of-living figures.

The post will carry the benefits of the Federated Universities Superannuation Scheme.

Good technical qualifications are required. Drawing-office and workshop experience in automobile or similar class of work is essential.

Applications should be made to the SECRETARY of the ADMIRALTY (C.E. Branch), London, S.W. 1. 1767

The Royal Sanitary Institute
PATRON: HIS MAJESTY THE KING.

EXAMINATIONS FOR SMOKE INSPECTORS.

The syllabus includes the subjects necessary in order to carry out the duties of Smoke Inspector. A knowledge of the administrative duties is required and also practical experience in connection with the working of furnaces.

The Examinations are held in many centres throughout England, and full particulars can be obtained from the SECRETARY, 90, Buckingham Palace-road, London, S.W. 1. 1756

City and Guilds (Engineering) COLLEGE.

There is a VACANCY for a LECTURER in the DEPARTMENT of MECHANICAL ENGINEERING and MOTIVE POWER. Practical experience and an Honours Degree of a British University or an equivalent academic qualification are essential. Salary £400 per annum, of which 5 per cent. must be contributed to the Universities Federated Superannuation Scheme.

Apply in the first instance to Professor W. E. DALBY, F.R.S., City and Guilds (Engineering) College, Exhibition-road, London, S.W. 7, on or before March 19th. 1766

Braintree Union.
TENDERS FOR BOILER.

The Guardians of the above Union invite TENDERS for the SUPPLY and FIXING complete of a NEW CORNISH BOILER, size 12ft. by 4ft. 6in., with necessary fittings complete. A specification containing necessary details and other information can be obtained on application to the Assistant Clerk, 71, Rayne-road, Braintree, to whom Tenders should be addressed in sealed envelopes, marked "Boiler Tender." Tenders to be sent in not later than Wednesday, the 14th March, 1923.

The Guardians do not bind themselves to accept the lowest or any Tender.

ALFRED HILLS,
1743 Clerk to the Guardians.

Borough of Newport, Isle of WIGHT.
TENDER FOR SWING BRIDGE, TOWN QUAY, NEWPORT, ISLE OF WIGHT.

The above Council invite TENDERS for the SUPPLY of a HAND SWING BRIDGE, 12ft. wide, 22ft. 8in. span, of bascule type or to swing horizontally.

Plans and further particulars can be obtained from the undersigned.

Sealed Tenders, with specifications and drawings, endorsed "Tender for Bridge," to be delivered at the office of the Town Clerk, Newport, Isle of Wight, not later than Saturday, 7th April, 1923.

E. A. SLATER, F.S.I., A.M.I.C.E.,
1777 Borough Engineer and Surveyor.

East Indian Railway.

The Directors are prepared to receive up to Eleven o'clock a.m. on Wednesday, the 28th March, TENDERS for the SUPPLY of :—

(1) ELECTRIC OVERHEAD TRAVELLING CRANES, &c.
(2) WHEEL LATHES

Copies of the specifications can be obtained at the Company's offices on payment of £1 1s. each. This fee will not be returned.

G. E. LILLIE,
Secretary.
73-76, King William-street, London, E.C. 4.
7th March, 1923. 1785

PUBLIC NOTICES

County of London.

The London County Council invites TENDERS for the MANUFACTURE, SUPPLY, and ERECTION at Greenwich Power Station of :—(i.) PIPE WORK (Steam and Feed); (ii.) MOTOR-DRIVEN FEED PUMP.

The specification, form of Tender, and general conditions may be obtained from the Clerk of the Council, the County Hall, Westminster Bridge, S.E. 1 (Room No. 215), upon payment to the Cashier of the Council of a deposit of £2. This amount will be returnable only if the tenderer shall have sent in a bona fide Tender and shall not have withdrawn the same. Particulars of the work may be obtained on application at the County Hall before the payment of the fee.

Tenders must be addressed to the Clerk of the Council and delivered at the County Hall, Westminster Bridge, S.E. 1, not later than 4 p.m. on Monday, 26th March, 1923. No Tender received after that time will be considered.

The Council does not bind itself to accept the lowest or any Tender.

JAMES BIRD,
1708 Clerk of the London County Council.

TENDERS INVITED.

County of London Electric SUPPLY CO., LTD.
BARKING POWER STATION.

The County of London Electric Supply Company, Limited, are open to receive TENDERS for the SUPPLY and ERECTION of the complete PIPING EQUIPMENT for their Barking Power Station, including Steam, Water and Compressed Air Piping, Water Storage Tanks, and Auxiliary Pumps.

Specifications may be obtained by manufacturers from the offices of the Company on application to the undersigned on or after March 9th, 1923, and on payment of a fee of Five Guineas for the first copy and Two Guineas for each subsequent copy. Sealed Tenders, marked "Tenders for Piping Equipment for Barking Power Station," are to be addressed to the Chairman and Managing Director and lodged at the registered office of the Company by Noon on April 10th, 1923. Sums paid for any number of copies up to three will be refunded on receipt of a bona fide Tender.

The Company do not bind themselves to accept the lowest or any Tender.

F. C. McQUOWN,
Manager and Secretary.
County of London Electric Supply Co., Ltd.
Moorgate-court, Moorgate-place, E.C. 1779

Manchester Corporation Water- WORKS.

The Waterworks Committee invite TENDERS for the SUPPLY and ERECTION at their Lostock Booster House, near Bolton, of the following PLANT, viz. :—

CONTRACT No. 2.—TWO 300 K.W. ROTARY CONVERTERS with STATIC TRANSFORMERS, H.T. and L.T. SWITCHGEAR, &c.

CONTRACT No. 3.—FOUR Electrically Driven CENTRIFUGAL PUMPS to deliver 3000/4000 gallons per minute against a head of from 40/90ft., together with SWITCHGEAR, PIPES, VALVES, &c.

Specifications and forms of Tender may be obtained on application to the Secretary, Waterworks Offices, Town Hall, Manchester, on payment of Two Guineas for each contract, which sums will only be returned on receipt of bona fide Tenders.

Any other information required respecting the work may be obtained from the Waterworks Engineer.

Sealed Tenders, endorsed as directed, must be delivered at the Waterworks Offices, Town Hall, Manchester, not later than the 7th April, 1923.

By Order,
P. M. HEATH,
Town Clerk.
Town Hall, Manchester,
5th March, 1923. 1765

PUBLIC NOTICES

Metropolitan Asylums Board.

TENDERS are INVITED for the PURCHASE of TWO SECOND-HAND GARRETT TRACTORS as under :—

(a) One No. 4, Compound Motor Tractor, No. 33,078, manufactured in 1917, insured with the Manchester Steam Users' Association for a working pressure of 180 lb. per square inch. This tractor can be viewed at Darenth Training Colony, near Dartford.

(b) One No. 4 Compound Tractor, No. 32,985, manufactured in 1917, insured with the National Boiler and General Insurance Company for a working pressure of 200 lb. per square inch. This tractor can be viewed at Leavesden Mental Hospital, King's Langley, Herts.

The following details apply in each case :—

Axle weight : front, 2 tons ; hind, 2 tons 2 cwt.

Diameter of wheels, 3ft. 7in. front wheels, 5ft. hind wheels.

Width and material of tyres : front, 6in., steel ; hind, 12in., steel.

Speed, 5 miles per hour.

Unladen weight, 4 tons 19½ cwt.

Also TWO TRAILERS, built by Messrs. Garrett and Son, suitable for use with either of the above-mentioned tractors.

These trailers are on view at Darenth Training Colony, near Dartford, Kent.

The tractors or trailers may be purchased separately or in one lot as a whole, and may be inspected between the hours of 10 a.m. and 4 p.m. on ordinary weekdays, or between 10 and 12 on Saturdays, on production of the Tender form.

Forms of Tender, upon which alone offers will be considered, may be obtained from the undersigned.

Tenders, addressed as printed on the form, may be obtained from the Offices of the Board, Embankment (corner of Carmelite-street), E.C. 4, and must be returned duly filled in not later than 10 a.m. on Monday, 26th March, 1923.

By Order,
G. A. POWELL,
Clerk to the Board.
March, 1923. 1727

Metropolitan Water Board.

TENDERS FOR THE MANUFACTURE, DELIVERY, AND FIXING OF FOUR LANCASHIRE BOILERS, PIPING, &c., AT THE LEE BRIDGE PUMPING STATION, ESSEX.

The Metropolitan Water Board invite TENDERS for the MANUFACTURE, DELIVERY, and FIXING of FOUR LANCASHIRE BOILERS, SUPERHEATERS, ECONOMISER, PIPING, FEED PUMPS, &c., at their Lee Bridge Pumping Station, Essex.

Forms of Tender, conditions of contract, specification and drawings may be inspected without payment of fee at the Offices of the Board, Chief Engineer's Department, Room 178, 173, Rosebery-avenue, Clerkenwell, E.C. 1, on and after Saturday, 10th March, 1923.

Contractors desirous of tendering may obtain the necessary documents from Mr. Henry E. Stillgoe, M. Inst. C.E., the Chief Engineer, on production of an official receipt for the sum of Three Guineas, which sum must be deposited with the Board's Accountant, and will be returned on receipt of a bona fide Tender, together with all incidental papers. Such payments and applications must be made between the hours of 10 a.m. and 4.30 p.m. (Saturdays 10 a.m. and 12 noon). Cheques must be made payable to the "Metropolitan Water Board" and not to individuals.

Tenders, enclosed in sealed envelopes, addressed to "The Clerk of the Board, Metropolitan Water Board, 173, Rosebery-avenue, E.C. 1," and endorsed "Tender for Boilers, Lee Bridge," must be delivered at the Offices of the Board not later than 10 a.m. on Wednesday, 4th April, 1923.

The Board do not bind themselves to accept the lowest or any Tender.

G. F. STRINGER,
Clerk of the Board.
Offices of the Board,
173, Rosebery-avenue, E.C. 1,
1st March, 1923. 1769

PUBLIC NOTICES

State Electricity Commission OF VICTORIA.
TENDERS FOR PLANT.

TENDERS are hereby INVITED for the SUPPLY, DELIVERY, &c., of the following for the Morwell Power Scheme.

Copies of Tender form, specification, contract conditions and drawings may be obtained or inspected at the office of

The Agent-General for Victoria,
Melbourne-place, Strand,
London, W.C. 2.

SPECIFICATION No. 23/22.—WATER SCREENING PLANT.

Prospective tenderers without Australian representation should note that time does not permit of their detailed Tender being received at this office by date of closing of Tenders, and should therefore cable direct the following particulars :—

1. Price.
2. Delivery.
3. Particulars marked with an asterisk in the schedule of plant details.
4. Whether or not one set may be delivered before the complete plant, and, if so, at what date.

Detailed Tender, on prescribed form, should be posted by earliest possible mail.

The Commission does not bind itself to accept the lowest or any Tender.

R. LIDDELOW,
Secretary.
State Electricity Commission of Victoria,
1641 Melbourne, Australia.

The Great Indian Peninsula RAILWAY COMPANY.
ELECTRIFICATION OF BOMBAY SUBURBAN LINES.

The Directors are prepared to receive TENDERS for the SUPPLY of certain PLANT in connection with the first instalment of the electrification of the above lines, namely :—

	Fee for Specification.
1. TRANSFORMERS	£2
2. CABLES	£2
3. SWITCHGEAR and ACCESSORIES	£2
4. COVERTER SETS	£2

Specifications and forms of Tender may be obtained at this office on and after the 12th March, 1923, on payment of the fee for the specification, which payment will not be returned.

Contractors may Tender for all or any of the above sections.

The fee should accompany any application by post Cheques and postal orders should be crossed and made payable to the Great Indian Peninsula Railway Company.

Tenders must be delivered in separate envelopes, sealed and addressed to the undersigned, marked "Tender for Transformers," or as the case may be, not later than Eleven o'clock a.m. on Tuesday, the 24th April, 1923.

The Directors do not bind themselves to accept the lowest or any Tender.

The Consulting Engineers to whom applications for any further technical information may be made are Messrs. Mers and McLellan, 32, Victoria-street, Westminster, S.W. 1.

R. H. WALPOLE,
Secretary.
Company's Offices,
48, Copthall-avenue, E.C. 2,
London, 7th March, 1923. 1766

The Madras and Southern MAHRATTA RAILWAY COMPANY, LTD.

The Directors are prepared to receive TENDERS for :

(i.) 4800 BRASS BOILER TUBES ;
(ii.) 7029 SPRINGS (Helical, Volute, and Slide Valve) ;
(iii.) 250 STEEL TYRES for ENGINES and TENDERS ;
(iv.) 527 CWT. PAINTS, &c. (Paints, Pumice Powder, 94,800 Blocks Artificial Pumice Stone, &c.) ;

in accordance with the specifications which may be seen at the offices of the Company. The charge for each specification is One Guinea, which will not be returned. Tenders must be sent in, addressed to the SECRETARY, not later than 2 p.m. on Tuesday, 27th March, 1923, and marked "Tender for Boiler Tubes," or as the case may be.

The Directors do not bind themselves to accept the lowest or any Tender.

Company's Offices :
25, Buckingham Palace-road,
Westminster, S.W. 1, 6th March, 1923. 1787

FOR SALE, SECOND-HAND RAILWAY RAILS, POINTS AND CROSSINGS.

The Dublin United Tramways Company (1896), Limited, is prepared to receive OFFERS for from 1500 to 2000 TONS of SECOND-HAND TRAMWAY RAILS ; also about 100 TONS of OLD CAST STEEL and MANGANESE POINTS and CROSSINGS, as they lie at the Company's Donnybrook Depot, Dublin.

G. MARSHALL HARRISS,
1742 General Manager.

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PUBLIC NOTICES

Urban District Council of WINDLESHAM (SURREY).

NEW SEWERAGE AND SEWAGE DISPOSAL SCHEME FOR BAGSHOT, LIGHTWATER AND WINDLESHAM.

UNEMPLOYMENT RELIEF WORKS.

GENERAL CONTRACT.

The Urban District Council of Windlesham invite TENDERS from responsible and experienced contractors for the CONSTRUCTION of these WORKS, which comprise about 10 Miles of Stoneware and Cast Iron Sewers, Brick, Concrete and Cast Iron Manholes, Flushing Tanks, Ventilating Shafts and Columns, Cast Iron Rising Mains, Air Mains, Engines, Compressors, Ejectors, Ejector Stations, Engine-houses, Balancing, Detritus, Sedimentation, Upward Flow, Storm, Humus and other Tanks, Percolating Filters, Laying Out Storm Water Area, Roads, Paths, and other incidental Works.

A copy of the specification and form of Tender may be obtained on application, in writing, to Major T. J. Moss-Flower, Civil Engineer, 28, Victoria-street, Westminster, S.W., and Carlton Chambers, Bristol, at his Bristol office, on and after 5th March, 1923, on deposit of a £10 Bank of England note, which will be refunded if provided a bona fide Tender be received and is not withdrawn before the sealing by the Council of one of the Tenders, and provided also that all documents supplied be returned to the Engineer. On production of a receipt for the deposit, persons tendering may inspect the plans at Bagshot on a day and at a time and place which will be communicated to them.

The contractor carrying out the work will be required to comply with the regulations of the Unemployment Grants Committee with regard to the employment of labour during the performance of the contract.

Sealed Tenders, endorsed "Tender for Bagshot, Lightwater and Windlesham Sewerage and Sewage Disposal Works: General Contract," are to be delivered at the Council Offices not later than Noon on 27th March, 1923.

The lowest or any Tender will not necessarily be accepted.

Dated this 24th day of February, 1923.

By Order,
EDWYN T. CLOSE,
Solicitor and Clerk to the Council.

Council Offices,
Bagshot (Surrey). 1664

Whitstable Urban District COUNCIL.

WATERWORKS.

TO WELL SINKERS.

The Whitstable Urban District Council invite TENDERS for the CONSTRUCTION of a BORED WELL, TRIAL PUMPING and other WORKS complete, to be constructed at their pumping station at Pye-alley, Clapham-hill, on the Canterbury-road, about two miles from Whitstable Station, on the Southern Railway, in accordance with specification, &c., prepared by Messrs. John Taylor and Sons, Civil Engineers, 36, Victoria-street, Westminster. Copies of the specification and plan, with form of Tender, can be obtained from the offices of the Engineers upon payment of £5, returnable.

Tenders to be endorsed "Tender for Bored Well," and to be delivered to Mr. J. F. Whichcord, Clerk, Council Offices, Whitstable, by Wednesday, the 21st March, 1923.

J. F. WHICHCORD,
Clerk to the Council.

Council Offices,
Whitstable, Kent. 1780

Boston Waterworks Company.

APPLICATIONS are INVITED for the POST of MANAGER and ENGINEER to this Company. The system is a gravity fed storage reservoir, one supplying about 20,000 consumers.

Applications, stating age, experience, and salary required, should be sent to the undersigned not later than the 31st day of March inst.

STANILAND and GROCOCK,
Clerks to the Company.

Boston, Lincs.,
7th March, 1923. 1791

Chesham Urban District Council.

The Chesham Urban District Council invite APPLICATIONS from qualified engineers with special experience in drainage for the POST of ENGINEER in connection with the work of thoroughly Overhauling, Examining, and Re-laying or Repairing and generally Improving the Sewerage System and House Connections in the Urban District. The work will be done by day labour and the person appointed will be responsible for the engaging and control of labour, the keeping of the necessary labour sheets, books and accounts, and will be required to attend the Auditor in connection therewith. An office and all office requisites will be provided.

The person appointed will be required to reside within the Urban District and to devote his whole time and attention to the duties and be directly responsible to the Council for the performance thereof.

The salary will be at the rate of £600 per annum and the appointment will be determinable by one month's notice from either side.

Applications, stating age and qualifications, with particulars of experience in the kind of work to be undertaken by the Council, and to be accompanied by copies of not more than three recent testimonials, to be sent to me not later than first post on Friday, the 30th March, 1923.

W. J. STANDRING,
Clerk of the Council.

Chesham, Bucks.,
March, 1923. 1788

Mersey Docks and Harbour BOARD.

PRINCIPAL TIMEKEEPER REQUIRED for Engineer's Department. Candidates, not in the Board's employ, to be under 40 years of age, and must have had experience in large works employing all classes of tradesmen and labour, and also have been a senior on or in charge of a timekeeping staff.

Applications, forwarding copy testimonials and stating age, experience, &c., and salary required to be marked on the envelope "Application, Principal Timekeeper," addressed to the undersigned and delivered before March 15th.

L. A. P. WARNER,
General Manager and Secretary.

Dock Office, Liverpool,
March 1st, 1923. 1750

The Municipality of Singapore, STRAITS SETTLEMENTS.

SECOND ASSISTANT GAS ENGINEER.

The Municipal Commissioners of Singapore REQUIRE an ASSISTANT GAS ENGINEER, age 28-32, of sound constitution and unmarried. The duties are to take charge of the outdoor work, including the laying of mains and services, the fixing, testing and repair of meters, the installation of gas in private houses and for public lighting, and in ordinary maintenance and distribution. Candidates must have some experience of gas manufacture and gasworks routine to enable them to assist in the gasworks in case of emergency. The appointment will be on agreement for three years with possible extension. The selected candidate must pass a medical examination as to his fitness for service in Singapore. A second-class passage will be provided by mail steamer, or a first-class passage by other steamer, with half salary during the voyage out. The salary will be 6000 dollars for the first, 6480 dollars for the second, and 6960 dollars for the third year, paid monthly, the value of the dollar being two shillings and fourpence sterling. For the first year the salary would be equal to £700 as above, with an allowance for such transport as may be required on duty. The selected candidate might be required to reside at the gasworks, where free unfurnished quarters would be provided. Applications, stating age and place of birth, and giving details of education, training, and experience generally, and in the use of gas appliances for domestic, industrial and power purposes, stating when free, accompanied by copies (only) of testimonials, and also personal references, to be lodged with Messrs. C. C. LINDSAY and PEIRCE, MM. Inst. C.E., 180, Hope-street, Glasgow, Agents in the Municipal Commissioners (from whose further information may be obtained), not later than Tuesday, 20th March, 1923. 1709

PUBLIC NOTICES

Bombay Port Trust.

ENGINEERING ASSISTANT.

The Trustees of the Port of Bombay REQUIRE the SERVICES of an ENGINEERING ASSISTANT with good experience in Girder, Bridge, and Roof Steel Work Design, Building Construction, and Heavy Masonry Work. Should preferably have obtained experience in connection with railway or dock work and have been some time with a good contractor. Capable of preparing designs and drawings and making calculations under the direct supervision of an Executive Engineer. Salary Rupees 350 per month, rising annually by Rupees 30 per month to Rupees 940, and, if married, with such married officers' house allowance as he may be eligible for under the rules of the service. Three years' agreement.—Applications, in writing only, stating age, whether married or single, education, technical qualifications, &c., with copies of testimonials, to the CONSULTING ENGINEERS and AGENTS, Bombay Port Trust, 2, Queen Anne's-gate, Westminster, S.W. 1. 1683

Shanghai Municipal Council.

PUBLIC WORKS DEPARTMENT.

ASSISTANT ENGINEER.

A fully qualified ASSISTANT ENGINEER is REQUIRED in the Public Works Department of the Shanghai Municipal Council. Candidates must be between 28 and 32 years of age and unmarried. They should hold the testamur of the Institution of Municipal and County Engineers or have passed the examination for the associate membership of the Institution of Civil Engineers, or hold a degree in engineering from a university in Great Britain. They should also have had at least two years' experience on constructional works.

Salary Taels 400 per mensem, under a three years' agreement, which is renewable at a higher salary in the event of satisfactory services. First-class passage is granted, with half-pay during voyage. Free medical attendance is provided, and the employee participates in the benefits of a superannuation fund. A tael at the present rate of exchange equals 3s. 1d.; exchange is, however, subject to fluctuation. Taels 400 per mensem at exchange 3s. 1d. is equivalent to about £740 per annum.

Particulars of the appointment and also full details as to the benefits enjoyed by municipal employees under their terms of service may be obtained from the Council's Agents, and applications, in candidates' own handwriting, with full information as to experience, &c., accompanied by copies of at least three recent testimonials and endorsed "Assistant Engineer" on the cover, should be forwarded at the earliest possible moment to

Messrs. JOHN POOK and CO.,
Agents for the Municipal Council of Shanghai.
68, Fenchurch-street,
London, E.C. 3,
March, 1923. 1780

Shanghai Municipal Council.

PUBLIC WORKS DEPARTMENT.

CLERK OF WORKS.

FOUR fully qualified CLERKS of WORKS are REQUIRED in the Public Works Department of the Shanghai Municipal Council. Candidates must be about 30 years of age and unmarried. Preference will be given to applicants thoroughly experienced in sewer construction and general engineering work. Salary Taels 285 per mensem, under a three years' agreement, which is renewable at a higher salary in the event of satisfactory services. Second-class passage is granted, with half-pay during voyage. Free medical attendance is provided, and the employee participates in the benefits of a superannuation fund. A tael at the present rate of exchange equals 3s. 1d.; exchange is, however, subject to fluctuation. Taels 285 per mensem at exchange 3s. 1d. is equivalent to about £527 per annum.

Particulars of the appointments and also full details as to the benefits enjoyed by municipal employees under their terms of service may be obtained from the Council's Agents, and applications, in candidates' own handwriting, with full information as to experience, &c., accompanied by copies of at least three recent testimonials and endorsed "Clerk of Works" on the cover, should be forwarded at the earliest possible moment to

Messrs. JOHN POOK and CO.,
Agents for the Municipal Council of Shanghai.
68, Fenchurch-street, E.C. 3. 1749

SITUATIONS OPEN

WANTED, Experienced CONTRACTOR'S ENGINEER for service abroad; age 35-40 years preferred.—Apply, giving full particulars, to Box 55, c/o Dawson's, 17, Craven-street, Charing Cross. 1799 A

WANTED, MECHANICAL ENGINEER, About 30, Gentleman, A.M.I.C.E. or equivalent, thorough scientific education and attainments, workshop experience, first-class draughtsman, well up in Constructional steel work, the various types of Internal Combustion Engines, Air Compressing Machinery, Mechanisms, Electricity, Wireless; able to spend a day or two at work at sea. Probation about two years, £350; permanency, £350 to £500, plus in each case equivalent of Civil Service bonus; superannuation.—Address, 1753, The Engineer Office. 1753 A

WANTED, TOWN SUPERINTENDENT for Waterworks on East Coast. Population about 60,000. Experience in distribution, main laying, waste detection, keeping of pipe plans and records, plumbing, fittings, meters, stores and office routine. Good management of all classes of workmen. Salary £900 per annum with house. Age 30 to 45. Application in own handwriting, with three recent testimonials.—Address, 1756, The Engineer Office. 1756 A

ASSISTANT ENGINEER WANTED; Must be quick and accurate in setting out work giving levels. Knowledge of Reinforced Concrete Construction essential.—Address, with particulars of experience, age, and salary, P7067, The Engineer Office. P7067 A

GEAR EXPERT.—An Important FIRM of MOTOR CAR ENGINEERS near London is REQUIRING the SERVICES of a GEAR EXPERT. Applicants must be thoroughly experienced on all points in connection with the cutting and quietening of gears of all types and qualified to deal with all matters in connection with same in an advisory and executive capacity. Full details of experience (stating firms), age, and salary required should be sent.—Address, 1712, The Engineer Office. 1712 A

GENERAL MECHANICAL ENGINEERING COMPANY in the Midlands REQUIRE the SERVICES of a young PRACTICAL ENGINEER with drawing-office, estimating, and commercial experience, to take a position and actively assist the management in the offices and works. University training preferred.—Address, P7036, The Engineer Office. P7036 A

STEAM BOILER TESTING ENGINEER, Junior, WANTED, Experience in Combustion, Coal and Gas Analysis essential. State fully experience, also salary required.—Address, P7038, The Engineer Office. P7038 A

WANTED, to Control Drawing-office, LEADING DRAUGHTSMAN, thoroughly conversant with Steam Engine and Condensing Plant Design. Sound technical experience essential.—Address, stating experience, age, and salary expected, 1741, The Engineer Office. 1741 A

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For continuation of Small Advertisements see page 3

The Central Electric Generating Station at Comines.

No. I.

INTRODUCTION.

THE Société l'Energie Electrique du Nord de la France supplies electrical energy for power and lighting to the Société Roubaisienne d'Eclairage par le Gaz et l'Electricité, to the towns of Tourcoing and La Madeleine-Les-Lille, to the Compagnie des Tramways de Roubaix-Tourcoing, to the Compagnie des Tramways l'Electrique—Lille-Roubaix-Tourcoing, to the Compagnie des Chemins de fer du Nord, as well as to some important textile and mechanical engineering firms. It owns the central generating station at Wasquehal, which was first put into service in October, 1907, and rapidly increased in capacity thereafter by successive extensions. This station was kept partially at work during the German occupation, but was entirely taken over in May, 1918. A certain number of the machines were removed and the remainder were very severely damaged, partly by want of attention and partly by actual sabotage perpetrated on October 16th, 1918—the day of the relief of Lille. After being freed from the Germans, the station was, as the result of very strenuous efforts, quickly re-instated, but its installed capacity —40,000 kilowatts—was found to be insufficient to satisfy the demands of industry, which, in being rehabilitated, called loudly for power in every direction. So, several months after the Armistice, the Société l'Energie Electrique du Nord de la France decided to erect a large steam generating station, the first portion of which would contain three generating units each of 25,000 kilowatts capacity, the idea being to be in a position to send out continuously 50,000 kilowatts —one unit being kept in reserve. The company proposes, later, to double the possible output by installing two further units of 25,000 kilowatts each.

THE COMINES CENTRAL STATION.

The new station, a view of which is given in Fig. 1, is situated at Comines, in the arrondissement of Lille. It is rather less than half-a-mile from the railway station and is built on the bank of the river Lys, which is an affluent of the Scheldt, and which in that particular place forms the frontier between France and Belgium. It is distant—see Fig. 2—between nine and ten miles from the three towns of Lille, Roubaix and Tourcoing, and rather over eight miles from the industrial centres of Halluin and Menin. By way of the Lys, the station is linked up with the colliery basins of the Departments of the Nord and Pas de Calais, as well as with those of Belgium and Germany. It can also obtain British coal by way of Boulogne, Calais, Dunkirk or Antwerp. Its position on the banks of the river also enables it to obtain condensing water in considerable quantity, for the Lys happens to be the stream with the largest flow of any in the neighbourhood. It and its tributaries have a drainage area of some 2775 square kilometres, and its officially ascertained flow is never less than 5.3 cubic metres per second, or over 4,000,000 gallons per hour. The river is ordinarily kept at a constant level of 10.40 m. above sea level by the barrage at Menin. The level of the ground on which the station is built is about one metre above the highest known flood level. The soil, however, is by no means of good weight-carrying character. Experiments showed that it would not satisfactorily support a greater load than 500 grammes—1.1lb.— per square centimetre, which works out at rather less than half-a-ton per square foot. The heavier parts of the buildings had therefore to be furnished with piled foundations, and 1552 piles from 23ft. to 26ft. long were driven under the boiler and engine-houses. Of that number 606 piles, which were of reinforced concrete, were required for the foundations of the generator units and of the long side walls of the engine-room.

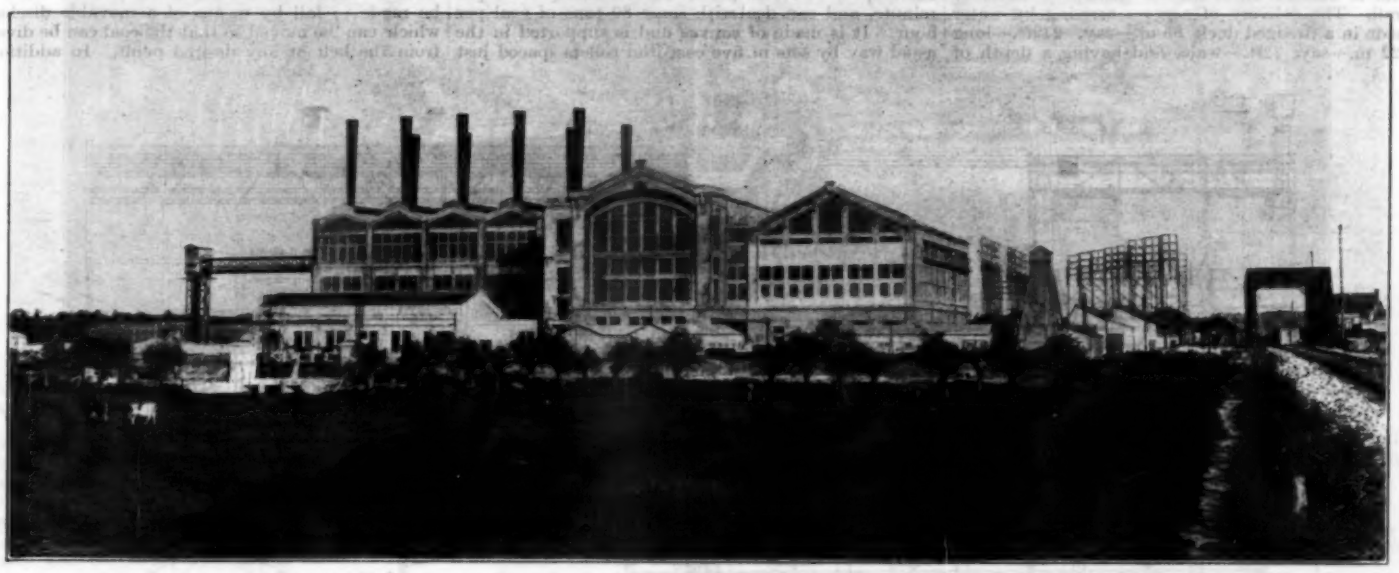


FIG. 1—GENERAL VIEW OF THE COMINES ELECTRIC GENERATING STATION

The lay out of the station, which is shown in Fig. 3, was governed by the following considerations:—The engine-room was arranged with its length at right angles to the river because that appeared to be the best method having regard to future extensions, and because it rendered the construction of the circulating water system easier. The boiler-house was placed at right angles to the engine-room, so that normally one generator might be supplied with steam from one row of boilers, a disposition which simplifies the steam piping and permit of easy control of the steam. It also avoids such difficulties as are met with when the boiler-house is of excessive length, and has other advantages.

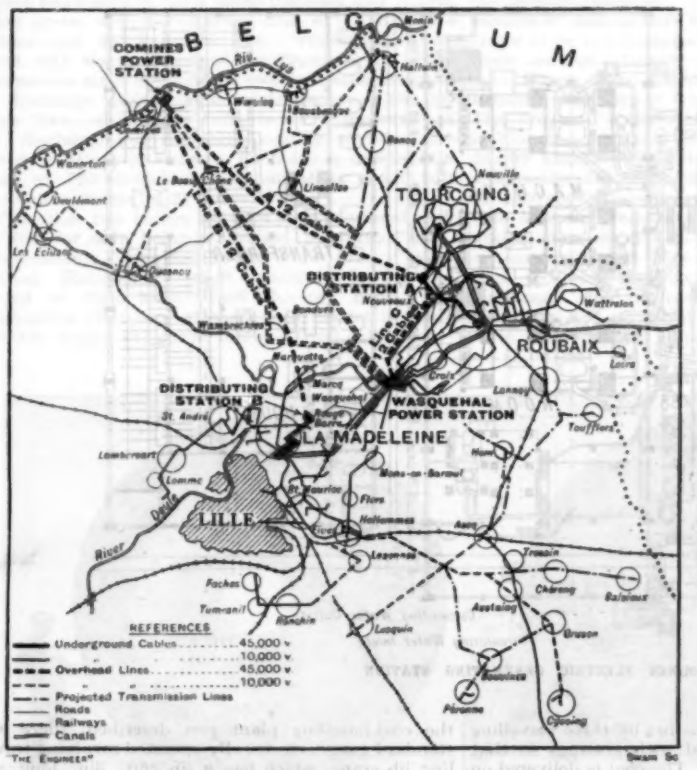


FIG. 2—MAP SHOWING GENERATING STATIONS AND TRANSMISSION LINES

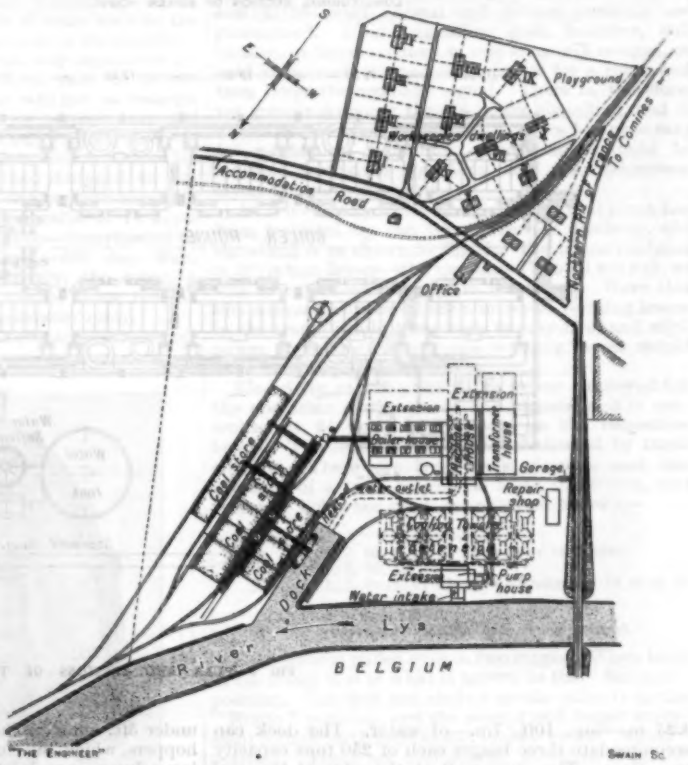


FIG. 3—LAY-OUT OF THE COMINES STATION

THE BOILER-HOUSE AND COAL-HANDLING ARRANGEMENTS.

The boiler-house contains ten Babcock and Wilcox boilers having a heating surface of 1000 square metres—or say, 10,764 square feet, and it is calculated that they will produce sufficient steam to operate to 25,000 kilowatt units continuously at full load. The circulating water is obtained by means of a pumping station erected on the bank of the river, which discharges into two reinforced concrete pipes 1.8 m. in diameter, from each of which branches are taken to the condensers.

Coal is brought on to the site either by water or by rail. The delivery of cargoes arriving by water is made in a dredged dock 85 m.—say, 279ft.—long by 22 m.—say, 72ft.—wide, and having a depth of 3.25 m.—say, 10ft. 7in.—of water. The dock can accommodate three barges each of 250 tons capacity at a time. The quay wall at the edge of the coal storage yard is formed by a range of reinforced concrete sheet piling constructed on the Ravier system—see Fig. 9, page 262. The fuel coming by rail enters by way of a siding which joins the Chemin de fer du Nord not far from the works, and which has several branches, as will be seen from the plan, Fig. 3. The discharging of the barges and of the railway wagons is brought about by means of three travelling transporters, a view of two of which is given in Fig. 10, page 262. The transporters, which are operated electrically, are furnished with grab buckets of 1.8 cubic metres—rather less than 2½ cubic yards—capacity. The grab can unload about 60 per cent. of the contents of wagons, the remainder being tipped into a pit from which it can afterwards be removed by grab. Some 60 tons of coal per hour can be discharged from wagons. The transporters have an effective range of 27.5 m., or just over 90 ft. There are one for unloading the barges and two for dealing with railway wagons. The different movements are in each case controlled from a cabin, which moves along the transporter with the grab. Each transporter can deal with a maximum of 80 tons of coal per hour. The coal is taken from the store heaps to the boiler-house by means of a belt conveyor, 700 mm.—very nearly 28in.—wide of 155 m.—or 508ft. 6in.—long, which passes over a drum driven by a 15 horse-power motor. The belt has a speed of 1.5 m. per second, or nearly 300ft. per minute, and can deal with some 80 tons of coal per hour. It is made of canvas and is supported in the usual way by sets of five cast-iron rollers spaced just under 5ft. apart. The belt is fed by three travelling hoppers, which are furnished with gratings so that large lumps are kept out. The coal is delivered on to the belt by a reciprocating mechanism driven by a 15 horse power motor, the arrangements being such that the quantity delivered can be varied from 20 to 80 tons per hour. By using these three loading hoppers simultaneously it is possible to charge the belts with blends of coal when that practice is desirable. Near the delivery end the coal is weighed on the belt by means of an automatic weigher of the Herrick type, which is furnished with an integrating recording mechanism guaranteed to be correct to within 1 per cent. The belt delivers the coal to a crusher, which is arranged in a pit and is driven by a 20 horse-power motor. The capacity of the crusher is 80 tons per hour; the coal being crushed into pieces of something like 1in. cube. The pit which contains the coal also forms the boot of two bucket elevators arranged side by side and each having a capacity of 45 tons per hour. Only one of these elevators is to work at a time, the other acting as stand-by. They are housed in a vertical open work tower—see Fig. 11, page 262. At the top the coal is delivered through a shoot into a hopper by means of which it is fed on to a belt conveyor 328ft. long, which is operated by a 7 horse-power motor, and has a carrying capacity of 45 tons per hour. After being taken by the conveyor across a lattice girder bridge of just over 130ft. span, the coal arrives over the bunkers above the boilers, into any of which it can be made to fall by means of a movable discharger which can be moved so that the coal can be diverted from the belt at any desired point. In addition to the coal-handling plant just described, there is a standard gauge, electrically operated revolving travelling jib crane, which has a jib 26ft. 3in. long and can carry a load of 2500 kilos. or a grab bucket with a capacity of 1000 kilos. This crane can travel at the rate of some 90ft. per minute.

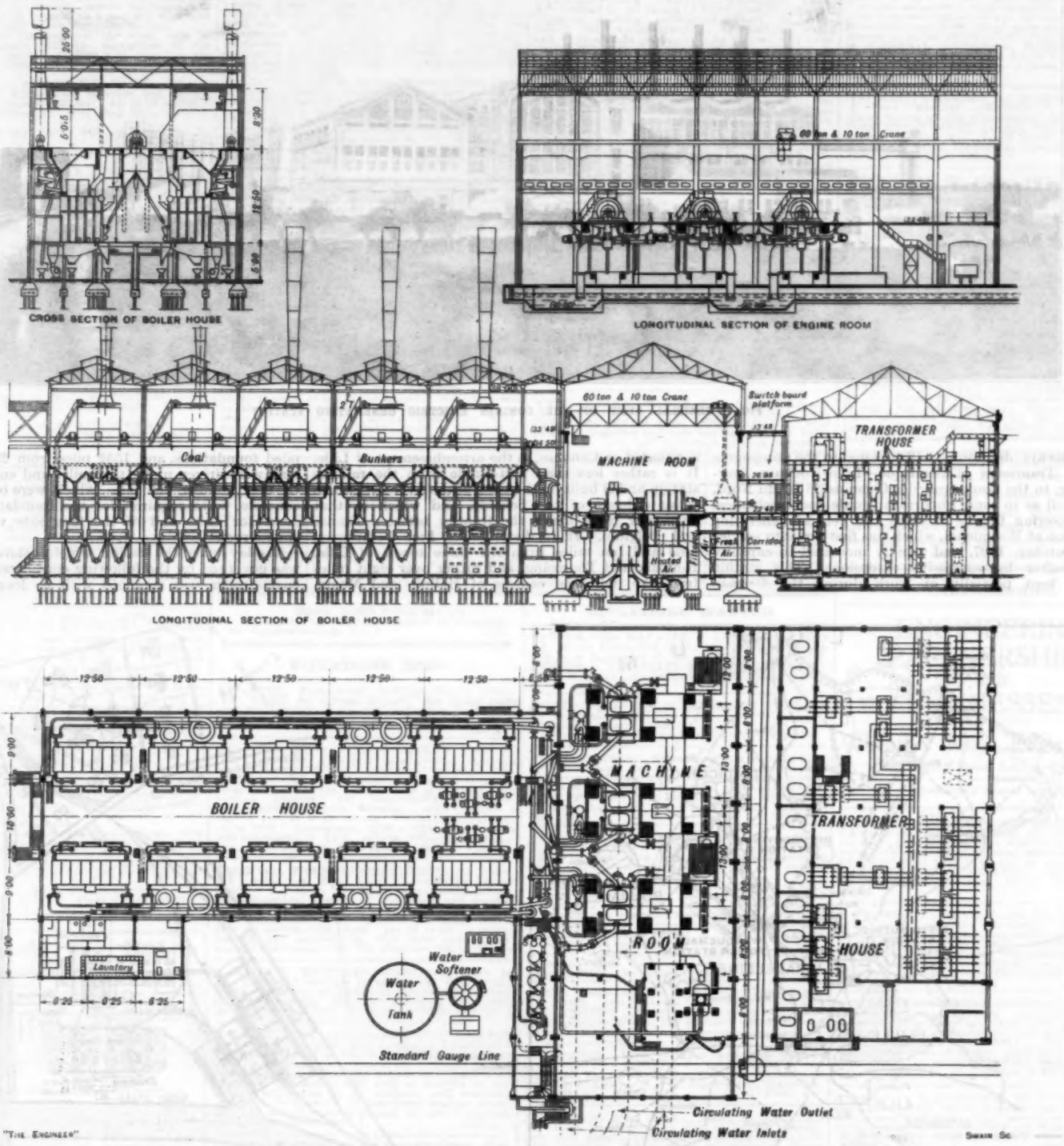


FIG. 4—PLAN AND SECTIONS OF THE COMINES ELECTRIC GENERATING STATION

The boiler-house—see Fig. 4—which is 62.5 m.—205ft.—long is built on the tops of 735 wood piles from 23ft. to 26ft. long, driven to refusal. The platform on which the boilers are erected is of reinforced concrete, and is taken up to about 16ft. 6in. above the

The transporters, the crushers and the jib-crane were supplied by La Société des Appareils de Levage, and the belt conveyors, the feeding hoppers and the elevators by La Société des Transporteurs Mécaniques. A petrol-electric locomotive of 120 horse-power completes the equipment of the coal yard.

floor level of the boiler-house. It is supported on 134 piers, which are also of reinforced concrete. Each of the boilers in working order weighs 312 tons. The economisers, which are arranged above each boiler at a height of 41ft. above the platform, each weigh 244 tons, including the chimney. There are two expansion joints in the width of the platform. The coal bunkers, which have a combined capacity of 600 tons, or sufficient for one day's operation of the station, are also of reinforced concrete and are arranged immediately over the firing passageway.

The boilers, which, as has been said, are of the Babcock and Wilcox marine type, having 1000 square metres of heating surface, are rated to produce 30,000 kilos.—66,120 lb.—of steam per hour when working normally and 88,160 lb. when being forced. These boilers, the working pressure of which is 21 kilos. per sq. cm., say 298.5 lb. per square inch, have drums 1.219 m.—say 4ft.—in diameter and 9.5 m.—say 31ft. 2in.—long; the tubes number 572 and are arranged in 52 sections of 11 tubes each. The volume of water contained when the boiler is at work is 29,840 litres—say 6565 gallons—the steam space being 373.4 cubic feet. Each boiler has a superheater having 500 square metres—say 5382 square feet—of surface, which is designed to give to the steam a total temperature of from 350 to 370 deg. Cent.—say from 662 to 698 deg. Fah.—and which is divided into two sections, one placed to the right and the the other to the left of the boiler. Eight of the boilers have each of them three Babcock and Wilcox chain grates with a combined area or 31.35 square metres—say 337.5 square feet. These grates are fitted with slag scourers of the Besmer type. The combustion air is supplied by two fans each designed to discharge 45,000 cubic metres,—say 1,589,000 cubic feet—of air per minute at a pressure—at the discharge outlets—corresponding to 90 mm.—just over 3½in.—of water. Each fan is driven at a speed of 720 revolutions per minute by a 220 volt three-phase motor of 21 horse-power.

The other two boilers are fired with powdered coal, the fuel for each being pulverised in three "aéro-pulvérisateurs" supplied by the Paris firm "Combustion Rationelle," each machine having an output of 2000 kilos.—4408 lb.—per hour. The combustion chambers of these two boilers is made specially large—113 cubic metres—3990 cubic feet—the object being that combustion may be quite complete before the gases reach the tubes. The coal falls from the overhead bunkers into the hoppers of the mechanical stokers or of the coal pulverisers, as the case may be, through sheet steel spouts furnished with Babcock and Wilcox distributors. On leaving the boilers the gases pass to Green's economisers, each of which has 500 tubes 13ft. long, the temperature of the gases after passing the economiser being about 392 deg. Fah. The chimneys are of the "Louis Prat" type, with induced draught, the height of the chimney above the economiser platform being 30 m.—say 98ft. 6in. Each chimney has two fans driven by 21 horse-power motors running at 720 revolutions per minute.

THE MACHINE ROOM.

The machine room has a length of 64 m.—say 210ft.—and a width of 24 m.—78ft. 9in.—and a height of 25.4 m.—83ft. 4in. In addition to the 606 reinforced concrete piles mentioned above, it was necessary to employ 300 piles in the foundations of this building. The foundations of the alternator units are separate from the rest of the building, and foundations capable of supporting five times the actual static load have been put in for the main generator units. Running alongside the wall dividing the engine-room and the transformer house—see Fig. 4—is a fresh air channel which is the full height of the mezzanine floor and which is entirely separate from the rest of the machine room. Air from this channel, together with air from outside the building, is passed through water spray filters, supplied by La Société de Condensation et d'Application Mécanique, to chambers formed beneath the alternators. The heated air discharged from the latter is led away through ducts into the space beneath the boilers.

In the machine room—which is served by an electrically operated overhead travelling crane, capable of dealing with a weight of sixty tons on the larger of its two hooks and of ten tons on the smaller—there are the following machines and apparatus:—

(*a*) Three turbo-alternator units, each of 25,000 kilowatt capacity, of which one will act as reserve. The proposed extension, if it be carried out, will include the provision of two further units, each of 25,000 kilowatt capacity. Each unit is driven by a Schneider-Zoelly impulse turbine designed to run at 1500 revolutions per minute, and to work normally with a steam pressure at the stop valve of 18 kilos. per sq. cm.—say 256 lb. per sq. inch—superheated to a temperature of 350 deg. Cent.—662 deg. Fah. Figs. 5, 7, and 8 show, respectively, the rotor, a diaphragm, and the casing of one of these turbine while Fig. 6 is a view of the generator rotor.

(*b*) Three 3-phase 50-period alternators each wound for a pressure of 10,500 volts between phases, directly coupled to its turbine, and supported by two bearings arranged for forced lubrication. The alternator can be short-circuited at full excitation. It has its own exciter coupled to a prolongation of its rotor shaft. The excitation voltage is 250.

As a safeguard against possible accident to one or other of the exciters, there has been provided a separate exciting unit, which is driven by an asynchronous motor with a wound rotor and arrangements for short-circuiting the rings and lifting the rings. The motor, which is fed with 220 volt three-phase 50-period current, is mounted on the same bed-plate, and drives directly a continuous current shunt dynamo of 160 kilowatts capacity, the voltage of which can be varied between 100 and 250.

In closing this portion of the article, we may draw attention to the illustration of the Workmen's Village which is illustrated in Fig. 12, page 262. This village has been laid out as a garden city, and the buildings have certainly a very attractive appearance.

FIG. 5—ROTOR OF 25,000-KILOWATT TURBINE

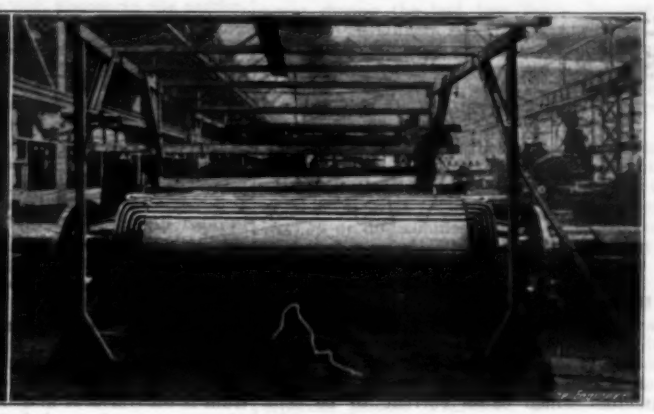
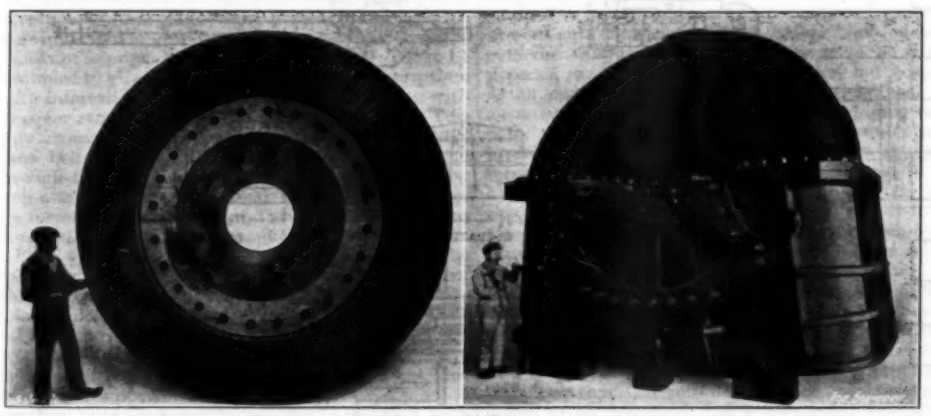


FIG. 6—ROTOR OF 25,000-KILOWATT ALTERNATOR



FIGS. 7 AND 8—DIAPHRAGM AND CASING OF 25,000-KILOWATT TURBINE

Route Signalling at Winchester, Great Western Railway.

THE benefits of the power operation of railway points and signals are well known, and there is little necessity for their recital. Briefly, they are (1) the locking frame is about one-third the ordinary length; (2) the consequently smaller signal-box may be placed in any position, as there is no point rodding or signal wires to "lead away"; (3) there is no limit to the distance points may be from the box; and therefore (4) one box can do the work of two or three mechanically operated boxes; (5) no manual exertion is necessary for the movement of points and signals; and (6) the exact normal and reverse positions are guaranteed. Route signalling goes, however, still further, as the movement of one lever will reverse, or hold at normal, the necessary points for a route and then lower the requisite signal. There is, therefore, yet greater economy than in power signalling, and in a case in our mind, where forty levers are necessary for mechanical signalling, twenty-eight would be required for power signalling, and only seventeen levers for route signalling.

At Winchester, where the Ferreira-Insell plant has been installed by the Great Western Railway, the signalling is as shown in Fig. 1. The frame contains only sixteen levers—the numbers 17 to 22 are not, as will be explained directly, in the frame. Were this box manually operated the number of working levers in the frame would have been twenty-five, and with power signalling twenty-one working levers would have been required.

Electricity at 120 volts is the power employed for the operation of the points and signals, and is controlled at 24 volts by contacts on the respective levers. The levers, in turn, are controlled by track circuits. There are five track circuits, and the presence of a train or vehicle locks the levers, and therefore holds the road, as indicated below:—

Track circuit.	Locks lever.
A ..	1, 7, 10, 15 (6, 13 when 18 or 19 is over).
B ..	6, 7, 10, 13, 15.
C ..	1, 7, 10 (8, 11 when 20, 21 normal; 15 when 21 normal).
D ..	2, 3, 4, 5, 12, 16.
E ..	prevents 8, 11, when over, being restored.

Each lever is pulled over in two stages. When back in the frame it is in what is known as the "Normal" position. The first and shorter stroke takes it to the "Route" position, and the second and longer movement completes the stroke and takes it to the "Signal" position. There are two similar movements in the reversal of a lever. The first and shorter takes it from "Signal" to "Track," and the second and longer from "Track" to "Normal." Thus, in pulling over a lever, the "Track" stage is omitted, and in the lever's return the "Route" stage is passed over.

Referring to the photographic reproduction—Fig. 2—illustrating the interior of the signal-box, the miniature character of the locking frame and its levers will be appreciated. Behind the levers are four rows of lights. The uppermost row has red lamps, the second green, the third orange, and the lowest white. Normally the uppermost (red) is shown. When a lever is moved, if the track be clear, the white light is switched in also; if the track be fouled no

white light appears. Thus, should an up train, standing at the up platform, have its tail on track C, so fouling the path for a down train leaving for Southampton, the bottom light behind lever 15 would not appear, thus advising the signalman that the lever was locked and it was no use to attempt to move it beyond the "Route" position.

If a lever be free the shorter stroke from "Normal" to "Route," by making the necessary contacts at 24 volts, operates the appropriate point contactors which cause current to be sent to the points concerned, and if any points be not in their correct position they are moved to suit the proposed movement. Thus, again taking lever 15 for an example, it would ensure that points 17 were normal and set for a trap against anything leaving the down siding. It would also make the nearer end of 18 lie for the main line with its further end acting as a trap. It would also set 19 to allow for a movement from the down main to the single line and reverse 21 so that it lay towards the up siding and acted as a catch point to prevent anything backing off the up main line.

When all this has been done—the point movements being made concurrently and not in series—the second indicator is illuminated and the orange light shown signifies that the route is made. A check lock that has prevented the full stroke of the lever to "Signal" is simultaneously withdrawn; the completion of the stroke which lowers the signal then becomes possible, and the red light is switched out and the green light appears.

The restoration of a lever has not quite the opposite effect. As already said, it can only go from "Signal" to "Track." This action restores the signal, but does not change the position of any of the points. When the signal is again at "danger" the green light changes to red. This does not, however, permit of the backward stroke of the lever being completed as long as anything is on the track circuits concerned—a condition indicated by the white light being out. Thus, whilst 15 may be put from "Signal" to "Track," and the signal put to "danger," its stroke cannot be completed until the train is off tracks A and B. In just the same way, when any one of signals 2, 3, 4, 5, 12, or 16 have been used it may be put to "danger," but the full stroke of the lever cannot be made until track D is clear. Obviously, this condition dispenses with the necessity for facing-point locking bars. When, however, the tracks concerned are clear the white light is again seen and the lever may be fully restored. When restored, the white light disappears.

Those points—*e.g.*, 17, 18 and 20—which are safety points and prevent trains and vehicles leaving sidings, are restored so as to act as traps; but, for instance, the replacement of 15 would not restore 19 nor the restoration of 2 or 3 cause 22 again to lie for the down main line. As long as the safety points are put to normal the other points may lie as they are and power be saved that would be used were they reversed, and, later, had again to be moved over.

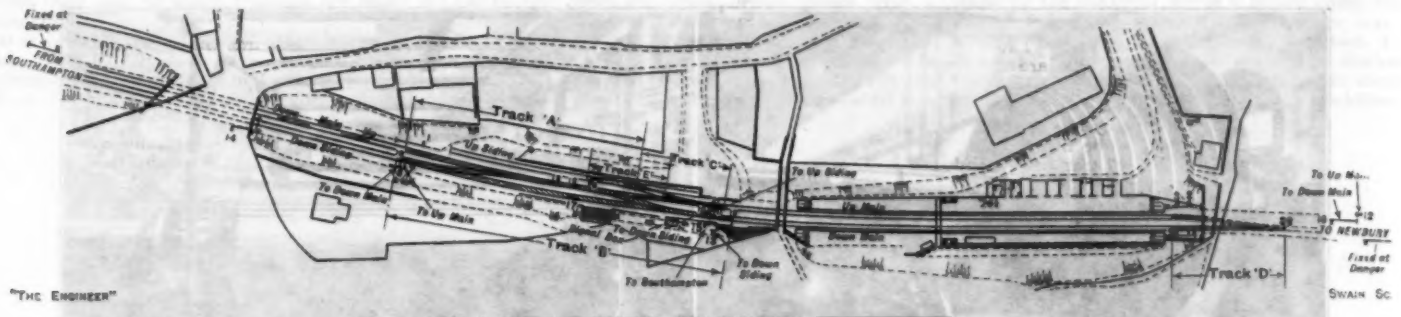


FIG. 1—ROUTE SIGNALLING ARRANGEMENTS AT WINCHESTER

FIG. 2—INTERIOR OF SIGNAL-BOX AT WINCHESTER

FIG. 3—LAY-OUT OF POINTS

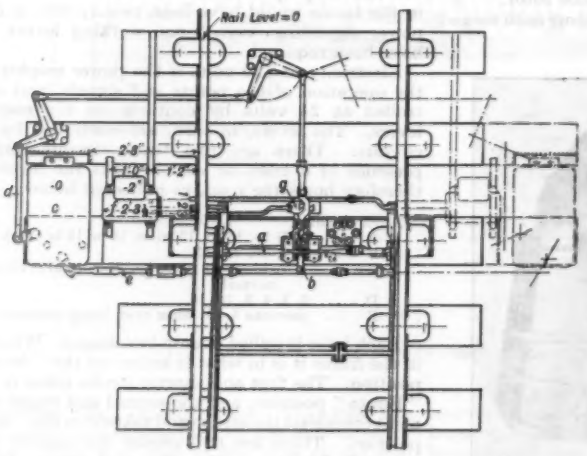


FIG. 4—LAY-OUT AT A PAIR OF FACING POINTS

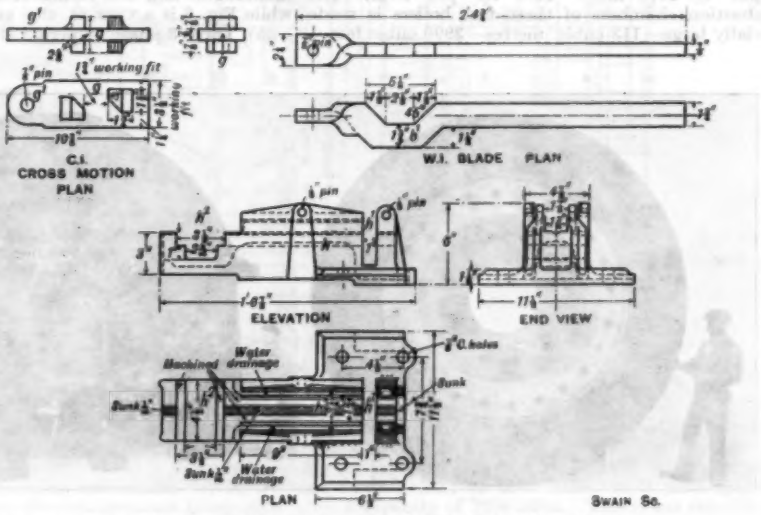


FIG. 5—DETAIL OF ROD 3 IN FIG. 2

PROVISION FOR INDIVIDUAL OPERATION.

On the lower front of the locking frame are six slides, numbered 17 to 22 inclusive, which are employed for the separate working of individual points for cleaning or other purposes. They, too, have indications which show the signalman the position in which the points are lying and that they are obeying the lever. When they lie as seen on the diagram in the signal-box, and in Fig. 1, a green light is shown. When points which also serve as safety points—*e.g.*, 17, 18, 20—are not lying normal, and therefore not acting as safety points, the indication is red instead of green, but the red is only switched in when the points are changed and are not acting as safety points. For points the position of which is immaterial—*e.g.*, 19, 21, 22—the alternative indication is orange.

In the event of his being unable to set up a route, indicated by the non-appearance of the yellow light, the signalman can test the different points by these slides. He must, however, first pull king lever No. 9—seen partly over in Fig. 2—from its normal "Route" position to "Signal" position. This action will lock every signal at "danger"—incidentally, the lever cannot be pulled if any signal be at "clear"—and release all the point slides. Such of these as are necessary can then be pulled to ascertain where the obstruction is. When put right and the slides restored, the king lever must again be put to the "Route" position. In case a lever cannot be restored from the "Track" to "Normal" position, owing, for instance, to the track relay failing to pick up, the king lever may be pushed from the "Route" to the "Normal" position, and this action will release the lever in question. The king lever must then again be put to the "Route" position, because, as already said, all signals are locked unless it is normal.

INTERLOCKING.

The fact that there are no independent point levers in the frame makes it necessary to arrange the interlock in an unusual manner. For instance, no interlocking is effected between signals through points. Ordinarily, for instance, No. 1 signal would lock points 20, and as signal 8 would require 20 there is no necessity for 8 and 1 to be interlocked. Or, again, as 2 and 3 would require 22 and 4 and 5 would lock 22 there is no need to interlock 2 and 3 with 4 and 5. All this is altered, and signal 1 locks signals 7, 8, 10, 11, 12, 14, and 15, and king lever 9. Points 18, 19, 20, and 21 are also interlocked, but by the route lever arrangement. Actually there appears greater freedom by this manner of interlocking.

Where this type of lever movement is convenient is that when a signal has been lowered and the lever is restored to "Track" position other levers that would be locked when the lever was in the "Signal" position would be free when in the "Track" position, even with the track occupied, provided no alteration of route were required. Thus, when an up train had to attach a horse box standing in the up siding No. 11 lever would open 20 and 21 points. The replacement of 11 to "Track" would put the signal to "danger," and although the lever was partly over, No. 8 lever

could be pulled to lower that signal for the train to return to the main line.

Again, signal 1, after being lowered and then restored, is locked in "Track" position when signal 2 is at "clear" by its lever being in "Signal" position. This arrangement ensures that 2 must be restored before route No. 1 can be interfered with. Signal 12 does the same with the routes of levers 10 and 11, and 13 and 15 with the route of signal 16.

SIGNAL AND POINT MECHANISM.

The locking frame is of an entirely new design of Siemens Bros. and Co. All electrical contacts are in the locking frame and work at 24 volts. The contactors, controlling the 120-volt circuits, are in the further cupboard on the left in Fig. 2, and the switchboard is in that in the foreground on the left.

The signals are provided with Siemens' motors. The point mechanism as fixed to the nearer end—to the box—of No. 18 points, No. 17 trap points, and to the further end of 19, is shown in Fig. 3. The motor and the detector switch-box in the foreground are for No. 18 points. Those in the background are for No. 19. The covers in the "four-foot" have been temporarily turned back so as to display the plungers.

Fig. 4, prepared from a drawing supplied by Siemens Bros. and Co., is a plan of the lay-out at a pair of facing points like 18 or 19. The drawing shows the points facing from the left, whereas No. 18 points, in the foreground in Fig. 3, are facing from the right. As seen, the stretcher rod *a*—Fig. 4—coupled to both switches, is bolted by plunger *b*, so that the first operation of the motor mechanism *c* is to give a right-to-left movement to the rod *d* so that the plunger *b* is completely withdrawn from the stretcher rod. This done, the motor engages with a crank that pulls rod *e* so that the switches are moved over. The motor continues to revolve, and a left-to-right movement is given to rod *d* and the plunger again bolts the stretcher rod, but in the other slot, seen in the photographic view. When the points have to be reversed the same

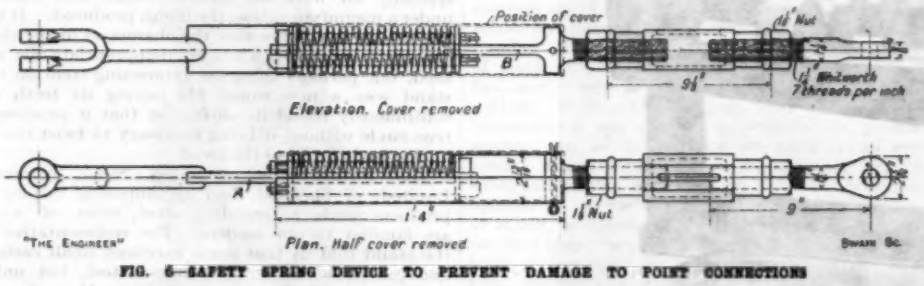


FIG. 5—SAFETY SPRING DEVICE TO PREVENT DAMAGE TO POINT CONNECTIONS

movements are imparted to the plunger, but the points are moved in the opposite direction. The electrical switches that ensure that the motor has done its work are in the box *f*. Rod 1 is coupled to the further switch, 2 to the nearer switch, and 3 detects the plunger movement by means of the plate *g*.

A NEW FACING POINT LOCK.

The facing point plunger is the Great Western Company's new pattern, of which the main feature is the manner in which the action of the plunger is detected. It is shown in Fig. 4 that the third rod 3 for the detector *f* came from the plunger. Fig. 5 gives the details of this. The plunger *b* is bevelled at b^1 as shown. Its longer end lies in the casting *h*, and at right angles thereto is the stretcher rod *a*—Fig. 4—in the slot h^1. When the points are unlocked the plunger is, as has been said, clear of the stretcher rod. In the recess h^2 lies the cross-motion plate *g* with corresponding bevels to those on the plunger. This plate is at right angles to the plunger—as seen in Fig. 4—and not as might be assumed from Fig. 5. The rod 1 is coupled to g^1, and its operation needs no description.

An interesting detail is the safety spring, seen with its cover removed in the foreground in Fig. 3. This is an arrangement provided to prevent point connections being damaged should the switches be run through in a trailing direction when closed against such a movement. When that happens the switches are forced over and they and the point connections damaged. There is, too, consequential delay to traffic.

Fig. 6 makes the arrangement clearer. The operating rod *d*—Fig. 4—is in two parts, the ends of which are inside the cover just referred to. The blade A is coupled to the stretcher rod and blade B to the rod from the signal-box. At the outer end of each are two cotters, and lying between each pair of cotters and around the two blades is a spiral spring. This spring has sufficient resistance to move A and B together, but is sufficiently resilient to yield to such undue pressure as would fall upon it should the switches be forced over against or away from the rodding. After this pressure had been removed the spring would return the switches to their former position. The blades are slotted so that if compressed they may dovetail.

It only remains for us to express our thanks to Mr. A. T. Blackall, M. Inst. C.E., the signal and telegraph engineer of the Great Western Railway, for an opportunity to inspect and describe this interesting new departure in railway signalling, and to Siemens Bros. and Co., Limited, Caxton House, S.W. 1, for their co-operation.

The Position of Reclaimed Rubber.

ALTHOUGH the India Rubber Manufacturers' Association has not given its blessing to the Stevenson scheme to raise and stabilise the price of raw rubber, and although the American manufacturers, who are the largest buyers of the commodity, have been saying nasty things about the commercialism of plantation companies, there is a branch of the rubber manufacture, not perhaps well known to the public, which has hailed the Stevenson Committee as a benefactor at a time of dire distress. This branch is one which is devoted solely to the reclaiming of old and scrap rubber of various sorts for re-use in the manufacture. Though the British reclaiming business is not comparable in magnitude, and one may add in importance, to that of America, yet we have several factories devoted to it, the three most important, all of which are situated in Lancashire, being British off-shoots of large American concerns. Closely allied to this industry is that of dealers in scrap rubber, that is the men who obtain old rubber goods of all sorts at as low a figure as will induce the owners thereof to put them in a heap ready for carting away to premises where they are sorted out ready for sale to the reclaimers.

Now the combined effect of the slump in trade and the recent fall of raw rubber to a figure as low as sevenpence per pound naturally had very serious results upon both the scrap collectors and the reclaimers, rubber manufacturers in this country at any rate not being inclined to buy old material at a price higher than that at which they could obtain new. In saying this we do wish it to be inferred that reclaimed rubber, although usually sold at a lower price than new rubber, is used merely on account of its price or that the finger of scorn can legitimately be pointed at it as an adulterant. This does not at all represent the facts of the case, because such rubber has special advantages when used in the manufacture of new goods, though it must be confessed that the British have been slower than the Americans in recognising its claims to the full. One of these advantages is a reduction in labour costs in the processes it has to go through in the factory compared with new rubber, and to-day the cost of labour and the overhead charges have far more to do with the price of rubber goods than the cost of the raw rubber has. This point, we are afraid, is not sufficiently appreciated by the buyer, who bases his ideas as to what he considers fair prices on the price of raw rubber as reported in his newspaper. Another advantage claimed for it, more particularly in America, is that it has a certain set and hardness and lacks some of the elasticity of new rubber. This point is of great importance in the rubber shoe manufacture, where it is found that shoes made of pure rubber lose their shape when on the last in the vulcanisation stove, while if a certain proportion of reclaimed rubber is present this defect is obviated. Here, then, is direct evidence that it is not by any means to be looked upon as an adulterant or a cheapener, but actually as an essential component. Another instance, and a somewhat striking one, of its recognised importance is its use by many of the leading tire manufacturers for the treads of pneumatics. It is now generally recognised that pure rubber should be used in the canvas, but that a definite advantage accrues from the use of a small amount of reclaimed rubber in the tread, a certain stiffness and tensile strength being thus ensured. At the present time two large rubber companies—the Goodyear in America and the Michelin in France—have reclaiming plants of their own, and use their own products in their tire treads.

In connection with this recognition of the virtues of reclaimed rubber for certain purposes the contention has been put forward recently by a prominent reclaimer that the action or benefit, or however it ought to be described, has a prominent analogy in metallurgy, where it is the common practice to use a certain proportion of scrap iron in making new iron. We do not know whether the use of shoddy in woollen cloths has found any doughty supporter on the same metallurgical analogy, but it is obvious that such claims, whether fanciful or real, are capable of development. In saying this we do not wish to be understood as poking fun at the reclaimer's analogy, which is certainly interesting and suggestive, and the close examination of disinterested persons may prove it to be well founded.

Turning now to another aspect of our subject, a good deal of time has been spent in the past, and a considerable amount of ingenuity expended in devising schemes for reclaiming not only rubber but also the fabric cotton or wool which forms so large a proportion of many rubber goods. Pneumatic tires, for instance, consist, roughly speaking, half of rubber and half of cotton, and in the case of cord tire, the proportion of cotton is still higher. So far, however, no satisfactory method of reclaiming the cotton has been found, and its destruction by hot alkali or acid, according to the reclaiming process employed, is the universal practice. The matter has cropped up again during the last two years, because the bad time the reclaimers have experienced has naturally acted as a spur towards the discovery of any way of effecting a reduction in costs. Nothing tangible, however, has resulted, and now that business is on the mend, the main incentive to further research is lacking.

A fact which has always militated against the greater progress of rubber reclaiming in this country is the ban in all Government specifications of the use of the material. The clause, "No reclaimed, reworked or de-resinified rubber is to be used," is to be found in practically all our Government specifications, and its presence and persistence is much resented by reclaimers as a sort of slur on their business. We are not going to discuss the *pros* and *cons* of this contentious matter here, and shall merely say that the term reclaimed rubber has a somewhat wide significance, such rubber being found upon the market in many qualities and at many different prices. Therefore, as its detection when used in rubber goods is a matter of the greatest difficulty, it is not surprising that those who are willing to pay the price for first-class goods should take steps to insure themselves against imposition. The position, however, has changed during the last ten years, and, as we have shown above, firms of the highest standing testify to the advantage that is to be derived from the use of a certain proportion of high-grade reclaimed rubber. The time, then, would seem to have come for our Government departments to reconsider their ban, and indeed we believe that a move in this direction was imminent and that reclaimed rubber was to be used in a certain large contract by permission of the War Office, when the end of the war put a stop to the whole matter.

It is outside our present purpose to describe the methods of reclaiming rubber, methods in which both the chemist and the engineer have collaborated to good effect, the interest of the bulk of our readers being limited, we imagine, to the position and market for the rubber scrap which is the raw material of the reclaiming works. A remunerative reclaiming industry means a fair price for scrap rubber, and although the large stocks of scrap at the works will take some time to get through, it may be taken for granted that the higher price of raw rubber will reflect not only upon the reclaiming industry in the way of increased sales, but also upon the rubber scrap industry. Rubber tires may not rapidly attain to the figure of £20 a ton ruling not so many years ago, but they certainly need not be given away. With regard to the prices ruling for scrap rubber in England at the present time, we do not care to give figures, as so much depends upon the conditions and circumstances of each deal. In America the business is better standardised, and its organisation on the large scale is reflected in the issue of market reports giving the ruling prices. The following quotation from a recent report of the New York Rubber Scrap market may prove interesting as some sort of a guide as to home values. As prices show frequent changes, we are merely giving the rough equivalent in sterling of the cent per pound quotations: Inner tubes, £18 to £20 per ton; pneumatic tire covers, £7 per ton; solid tires, £14; mechanical rubbers, according to quality, £7 to £30 per ton. These quotations are for carload lots delivered at the reclaimers' works, and it is most unlikely that any individual or firm having a small amount of waste rubber on which carriage has to be paid will realise at the above prices. As we have said, general conditions differ here from those in America, and transactions cannot be carried through on identical lines. The general position, however, as regards supply and demand does not differ greatly, and it is only natural that the upward trend of prices in the New York market should be reflected in dealings in rubber scrap in this country, and we shall be surprised if our long-time moribund market does not shortly show signs of animation.

An interesting point with reference to reclaimed rubber has regard to how often it can undergo the process of reclaiming and continue to give a uniform product of recognised quality. It has been stated on good authority, that in America reclaimed rubber is used in the proportion of 1 lb. to 3 lb. of new rubber, while in England the proportion is 1 lb. to 8 lb., so we see that in America, at all events, a good deal of the rubber used has certainly been reclaimed several times, and according to the reclaimers no deterioration is apparent in the oft-reclaimed rubber, and the fact that the business has been going on and, moreover, progressing for so many years, certainly seems to bear out this contention. At the same time it should be said that the claim is not universally accepted by British rubber manufacturers, some of whom say they have proof to the contrary. With regard to this point, which does not call for elaboration here, we shall only say that experiments and

comparisons must be very carefully carried out, because, to repeat what we have already said, the generic term reclaimed rubber refers in trade circles to products of widely different composition and value, which have been produced, moreover, by very different methods.

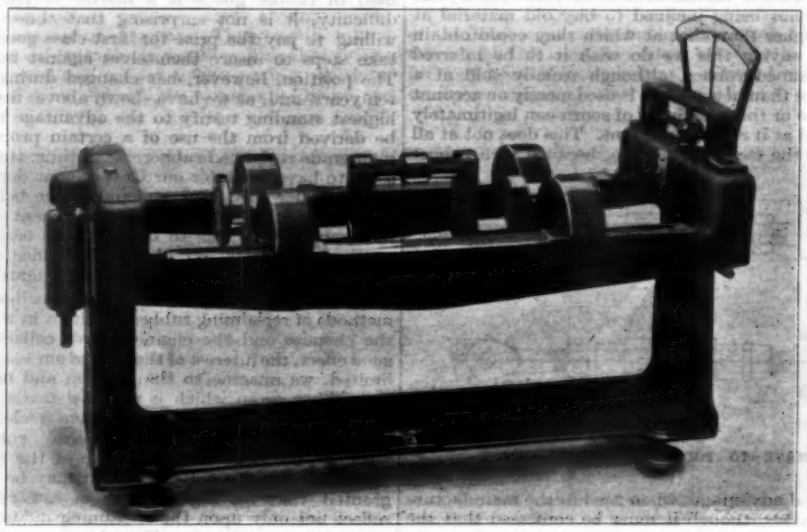
To conclude, though our main object has been to draw attention to a welcome revival in a much-depressed industry, we have taken the opportunity of giving reasons for our belief that, even with no shortage of raw rubber, the business of reclaiming is quite unlikely to be abandoned.

The British Industries Fair.

No. III.*

We conclude below our description of engineering exhibits at the Birmingham section of the British Industries Fair, which closed on March 2nd.

W. and T. Avery, Limited, of Soho Foundry, Birmingham, had a large selection of weighing machines, including one in which the major part of the balance is effected separately from the final adjustment, so that the greater part of the load may be roughly dumped on the platform, without fear of damaging the delicate mechanism, and the weight then finally adjusted. There was also a number of testing machines, most of which have already been



AVERY STATIC BALANCING MACHINE

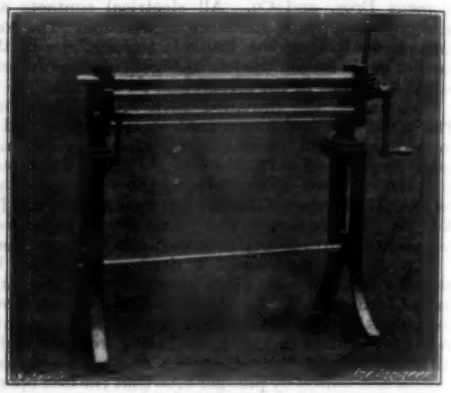
described in The Engineer, and the static balancing machine shown in one of our illustrations. The body to be balanced is supported in a cradle pivoted upon hardened steel knife edges and bearings, the line of which is made exactly to coincide with the axis of the body under test. The smallest error of unbalance is immediately shown in terms of inch-drams or inch-ounces by an indicating pointer against a graduated chart. The body may be turned through various angles while resting in the cradle, in order to determine the out of balance error at any position. This type of machine can, of course, also be utilised for balancing much heavier and larger bodies, such as electric rotors, steam turbines, &c., with a corresponding degree of sensitiveness and accuracy. There was also, on this stand, an automatic and self-indicating scale for liquids, for such services as the weighing of sugar cane juice, fuel oils, chemical liquids, &c. It is particularly suitable for the precision measurement of the discharge from surface condensers or of feed water. Its accuracy when weighing water is guaranteed to be within 0.1 per cent., and, in striking contrast with all instruments for the volumetric measurement of liquids, it is an exceedingly simple matter to check its accuracy at any time by observing the balance of a weighing, and to make any small adjustment found necessary by means of the compensating weight. In these scales the weigh hopper overturns to discharge, thus obviating the use of a valve which may leak or stick. A simple adjustment is provided, by means of which the hopper is made to remain in the overturned position for any desired length of time in order to ensure complete drainage when weighing viscous liquids.

The Godfrey Engineering Works, of Boundary-road, Westbury-avenue, London, N. 22, was exhibiting the oxygen jet cutting machine, which we have already fully described, fitted up in conjunction with a small electric oven for heating the oxygen on its way to the blow-pipe. Generally speaking, the machine has been little altered since it was last exhibited, but some refinements have been added. For instance, the feed screws are now fitted with split nuts so that coarse adjustments can be made rapidly. The inventor told us that a new attachment, which is practically completed, will give the cutting jet a steady linear speed regardless of the direction of motion. An interesting example of the kind of work turned out by the machine, which was shown in the stand, was the end plate for the laminated pole pieces of an electric generator for South Africa. These pole pieces are cut out with the jet in just over 17 minutes, whereas it used to take about 6 hours to saw them out.

C.A.V. Small Tools, Limited, 181, Queen Victoria-street, London, E.C. 4, was showing the small bench lathe, which we described in connection with the recent Model Engine Exhibition, fitted up with an electric motor and some chucks, while the engineers' tools on the stand included several new classes.

Walter Frost, of Eagle Ironworks, Rochdale, had a number of machines for sheet metal work, including the set of bending rolls shown in one of our illustrations. One of the rolls of this machine has a sliding bearing, so that it may be pulled out of its housing and the work slipped off the end without it being necessary to spring it open. The two ends of the adjustable roll are raised or lowered simultaneously by means of a pair of quadrants fixed on the opposite ends of a shaft. By means of an ingenious device this set of rolls can also be used for making square pipes. For this purpose a triangular bar is set between the two faced rollers so as virtually to provide a right angled corner on the upper roll. The plate to be bent is then clamped between the bar and the lower roll. By raising the adjustable roll the plate is bent round the corner, and the process may be repeated for all four corners so long as the resulting square pipe is large enough to embrace the top roll and the corner bar.

The British Oxygen Company, Limited, of Angel-road, Edmonton, London, N. 18, had an interesting collection of metal cutting apparatus, including a machine for making straight cuts with ordinary town gas, at main's pressure as the heating medium. We tried several cuts with this apparatus and found that it would go through a piece of steel 4in. by 1in. in 60 sec., of which time about 40 sec. was occupied in the preliminary heating. The blow-pipe is fed across the work by a small electric motor geared to a chain stretched along the joist that forms the bed of the machine. There was also on this stand a number of special cutting jets, such as one for cutting off rivet heads flush with the plate. In this case there are three orifices in line, the two outside ones being for the acetylene used for heating, while the centre one



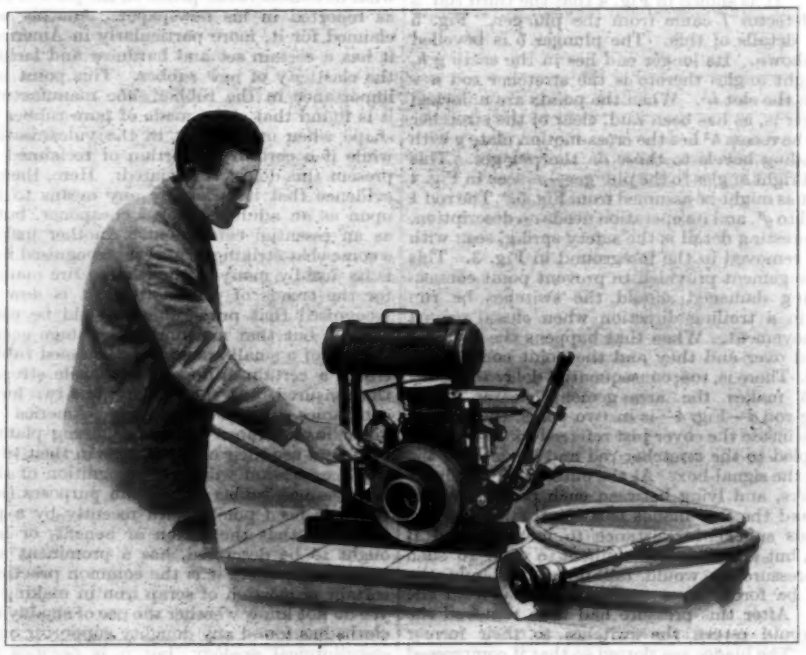
FROST BENDING ROLL

supplies the oxygen for cutting. Another blow-pipe was arranged for cutting out boiler tubes, just inside the tube plate, while there was also one, of the injector type, for brazing and cast iron welding with coal gas.

The Taylor File and Tool Company, Limited, of Farnley, near Leeds, had a large variety of files, cut specially for work on definite metals and showed, under a magnifying glass, the filings produced. It was interesting to observe how the characters of the chips changed completely when an inappropriate file was used, but perhaps the most interesting item on this stand was a new round file having its teeth cut continuously round its surface so that it produces a true circle without it being necessary to twist the file during each stroke of the hand.

The Firth-Brearley Stainless Steel Syndicate, Limited, of Sheffield, had an imposing display of products made of stainless steel, most of which are familiar to our readers. The representative on the stand told us that some excellent small castings had just been made in stainless steel, but unfortunately they had not arrived at the Fair when we left.

Frank Gilman, of Grange Works, Grange-road, Smethwick, was showing a collection of the sealing tools, for pneumatic or electric operation, with which his name is generally associated, together with the little self-contained set shown in one of our engravings. It is driven by a 2¼ horse-power petrol engine, and is intended for operating rotary sealing tools. A friction wheel mounted on a swinging lever is brought into engagement with the engine fly-wheel and is used to drive the sealing tool through a flexible shaft. The friction wheel can be disengaged from the engine, and a Bowden wire running alongside the flexible shaft is provided for stopping and starting the tool without the workman having to go to the engine.



GILMAN PORTABLE SCALING SET

* No. II. appeared March 2nd.

Our illustration shows the method of starting the engine by pulling on a short length of belt passed over the pulley. These little units are obviously very convenient for such work as scaling bridges, &c., where neither electricity nor compressed air supplies are available.

The Fraser Patent Power Hammer Company, of Leven, Fife, had a spring hammer of rather unusual design, as shown in the accompanying illustration. A crank and slotted crosshead provide the reciprocating motion for the tup through the intervention of a coiled spring arranged in the bored guide. The belt pulley is mounted on an eccentric sleeve on the crank shaft. The driving connection between the pulley and the shaft is effected by two V grooved friction discs, which are engaged, or disengaged, by rotating the eccentric bush, through the link work and foot treadle shown. The same treadle is connected with a brake on the crank shaft in such a manner that when the friction discs are drawn apart the brake is put on. The hammer is made in three sizes, giving blows of 56 lb., 112 lb., and 280 lb., at speeds ranging about 200 revs. per minute. The power required is 2, 3 and 5 horse-power respectively for the three sizes.

The Vono Company, of Duport Foundry, Dudley Port, Staffs., was exhibiting a very fine type of cast steel parallel-jaw vice, which, we were told, is being manufactured at a price comparing favourably with that of the usual cast iron type. Automatic and Electric Furnaces, Limited, 173-5 Farringdon-road, London, E.C. 1, had a large stand on which there were shown a number of Wild-Barfield hardening furnaces, but this subject has been dealt with so recently in THE ENGINEER that it is unnecessary to

FRASER POWER HAMMER

enlarge upon it here. Kelvin, Bottomley and Baird, 299, Hither Green-lane, London, S.E. 13, had a variety of instruments fitted with quartz mercury vapour lamps; while the adjacent stand of the Park Royal Engineering Works displayed new types of circuit breakers and a truck type of switchgear. The stand of Royles, Limited, Irlam, Manchester, was furnished with examples of this firm's products embodying the familiar Row tube.

Hollings and Guest, Limited, of Thimble Mill-lane, Birmingham, had a number of hydraulic presses and a bundling machine, all very similar to those exhibited at the Fair last year; while Jones and Shipman, Limited, of Leicester, concentrated on the valve re-seating tool they exhibited at the Model Engineering Exhibition. The Cape Asbestos Company, Limited, 23, King-street, London, E.C. 2, displayed a wide range of the uses to which South African blue asbestos can be put, and we might mention that we overheard a chemist at the Fair commend the filter fabrics of this company strongly. Lucas Furnaces, of 45, Newhall-street, Birmingham, had some furnaces for tempering and heat treatment embodying a regenerative principle for the air supply; while Messrs. Gibbons, of Dudley, had a model of a continuous annealing furnace in operation.

Productive British Grinders, Ltd., 38, Moseley-street, Birmingham, had some ingenious grinding spindles, for use on the lathe, in which a simple right and left-handed thread is used to keep in the lubricant and keep out the grit from the bearings. Ackroyd and Best, Limited, of Morley, near Leeds, showed several patterns of miners' lamps, together with lighters for use in the mine and at bank. The exhibits of W. Canning and Co., Great Hampton-street, Birmingham, were of the familiar type associated with the electro-plating and polishing trade; while Eyre and Sons, Limited, of Chesterfield, had a fine display of hemp ropes. J. B. Stone and Co., Limited, 135, Finsbury-pavement, London, E.C. 2, showed the patented "nibbling" machine, for cutting out awkward shapes in sheet metal, that we have already described, together with a new pattern with a deep and high gap for accommodating bent work. J. Broughton, 41, Great Charles-street, Birmingham, exhibited some guards for protecting the operators of machine presses and a new output meter.

Among the other exhibitors there were Messrs. Accles and Pollock, of Oldbury, Birmingham; the Edison and Swan Electric Company, Ponders End, Middlesex; E. H. Bentall and Co., Heybridge, Maldon; Geo. Salter and Co., West Bromwich; the Delta Metal Company, Dartmouth-street, Birmingham; and the Consett Iron Company, but their products are too well known to our readers to need any description.

Superheater Tank Locomotives in Suburban Service.

By F. W. BREWER.

OTHER things being equal, the economic value of superheating in locomotives is affected, not by the type of engine, but by the kind of service on which the engine is employed. As a rule, the necessary degree of superheat can be more easily maintained on long and comparatively unbroken runs than when working traffic requiring frequent halts, with, consequently, the repeated opening and closing of the regulator. When the engine is running with steam on, the action of the exhaust keeps the fire-box temperature appreciably in excess of the temperature prevailing when the throttle is shut. Thus any work which is of an intermittent character, involving many stops, would appear, on the face of it, to be more or less unfavourable to superheating, according to the degree to which the heat available fluctuates. For this reason, the great majority of superheater locomotives are of the tender type, being intended to run relatively long distances without stopping. In a number of instances, however, tank engines, some of them of exceptionally large size, with sufficient fuel and water accommodation to enable them to perform work corresponding with that of tender locomotives, are in use, principally in passenger service. In addition, there are numbers of superheated steam tank engines engaged on local and suburban traffic, and it is in this connection that opinion is divided as to whether superheating is, or is not, advantageous. Considerable economy has resulted from the application of superheating to long-journey locomotives, irrespective of type. Therefore, despite the usually more unsatisfactory conditions obtaining in the case of short-distance stopping traffic, it is thought that some economy, even if a smaller percentage, might not unreasonably be expected with such traffic, if the apparatus be designed to give an adequate amount of superheating surface. In some instances, the results have been distinctly encouraging; in others, just the reverse.

The first line to apply superheating on any scale to tank engines in this country was the London, Brighton and South Coast. This company's first superheater tank engines were built in 1907. They were 4–4–2's with 21in. by 26in. inside cylinders, 6ft. 7½in. coupled wheels, 1281 square feet of heating surface, 24 square feet of grate area, and 160 lb. steam pressure. They weighed in working order 76 tons. These engines, tried on main line work against a non-superheater tank engine with 19in. by 26in. cylinders, 1625 square feet of heating surface, 180 lb. pressure, and weighing 73 tons, but of the same type, and generally otherwise alike, showed an economy, ranging over a period of six years, of over 15 per cent. in coal, and approximately 30 per cent. in water consumption. The importance of the last-mentioned saving was demonstrated when, in 1909, two of the London, Brighton and South Coast Railway superheater tank engines took their turn in alternately running, in conjunction with a London and North-Western 4–4–0 non-superheater tender locomotive, the then through express train from Brighton to Rugby, and *vice versâ*. The tank engines, it was found, could cover the 92 miles between Rugby and Croydon without stopping for water, their consumption being 19 gallons per mile, while that of the London and North-Western Railway tender engine was 36 gallons per mile, or nearly twice as much. On the other hand, on suburban work, a series of similar but slightly smaller 4–4–2 superheater tank engines failed to give any satisfaction on the score of economy in coal and water consumption. These particular engines had 20in. by 26in. cylinders and 5ft. 6in. coupled wheels; the evaporative surface proper was 883 square feet, the grate area 17.43 square feet, and the steam pressure 170 lb. per square inch. There were 18 superheater elements as compared with 21 elements in the case of the larger 4–4–2 class. This difference may have had some effect on the results, but the non-success of the suburban series was attributed chiefly, if not entirely, to the inability of the engines to maintain a high degree of superheat for a sufficient length of time to ensure economy in coal consumption, in consequence of making several stops.

Only slightly better results have been obtained on the Great Eastern Railway in the case of local traffic. For this line, two 0–6–2 tank engines were built in 1914 for trial purposes. One was fitted with a superheater, the other engine working with saturated steam. Except for the unavoidable differences in heating surface, both locomotives were alike and weighed about 61½ tons. The cylinders were 18in. by 24in.; the coupled wheels were 4ft. 10in., the grate area was 17.7 square feet, and the boiler pressure 180 lb. per square inch. The heating surface of the non-superheater engine was 1394.2 square feet, while that of the superheater engine was 1291.7 square feet, of which 102.4 square feet were contributed by the superheater elements of the steam tubes. These engines were engaged in working suburban passenger trains which made thirteen stops in 16½ miles in a booked time of 55 minutes. On this service, the coal consumption of the superheater tank engine was 3 per cent. less than that of the saturated steam locomotive, and the water consumption about 10 per cent. less.

Nevertheless, with an engine of the same type, the Great Northern Railway has effected a saving of 18.7 per cent. in coal. In 1918, this company equipped one of its 0–6–2 suburban tank engines with a superheater, and ran it in competition with a number of otherwise identical, but saturated steam, tank engines. Apart from the fitting of the superheating apparatus itself, the only change made was the substitution of balanced slide-valves for the ordinary valves with which the engine was formerly provided. The non-superheater engines had, therefore, unbalanced valves. All the engines were employed in the London suburban district of the Great Northern Railway, and under the same conditions of working. No special observations were made, a fact which renders the economy obtained with the superheater engine all the more noteworthy. Covering a period of about four years, the coal consumption of that locomotive averaged 52.3 lb. per mile, as compared with 64.4 lb. per mile for the saturated steam tank engines, equivalent to an economy for the former of 18.7 per cent. This, it will be seen, is a very satisfactory figure. The dimensions common to both classes were:—Cylinders, 18in. by 26in.; coupled wheels, 5ft. 8in.; grate area, 19 square feet; steam pressure, 175 lb. per square inch. The superheater engine had 1164 square feet of heating surface, including 192 square feet in the superheater steam tubes, and weighed in working order 64 tons 18 cwt. The non-superheaters weighed 65 tons 17 cwt., and had 1250 square feet of heating surface. The Great Northern Railway has now a large number of 0–6–2 superheater tank engines, the later examples having 19in. by 26in. cylinders.

Another line which has lately been investigating the question is the North Staffordshire Railway. The engines used in these tests were also of the 0–6–2 type. The company's experience with superheater tank engines, however, dates from 1911. In that year superheating was applied to a number of 4–4–2's, and a year or two later to some 0–6–4's. There were no saturated steam tank locomotives of these or other designs with which to make suitable comparisons. The non-superheaters included tank engines of the 0–6–2 notation, and when in 1920 an additional series of them was under construction, it was decided to fit one of them with a superheater, and to test it against the others of the same type and dimensions. All the engines employed in the trials had 18½in. by 26in. cylinders, 5ft. coupled wheels, 19.5 square feet of grate area, and 175 lb. per square inch pressure (afterwards reduced to 160 lb.). The slide-valves were unbalanced. The superheater engine weighed 64 tons 19 cwt. and had 1131 square feet of heating surface, 195 square feet being furnished by the superheater steam elements. The other engines had a total heating surface of 1000 square feet, and their weight in working order was 63 tons 17 cwt. Three of the engines were put to work local stopping trains, viz., the superheater and two non-superheaters. The average distance between the stations was rather greater than in the case of the London suburban lines, and this factor possibly explains the relatively high percentage of economy recorded. Generally, the saving in fuel was 20 per cent. in favour of the superheater tank engine, and this figure is approximately the same as that obtained in long-journey service. The economy in water consumption varied from 16 per cent. to 24 per cent.

It will be remarked, therefore, that as regards the different lines mentioned in this article, the results shown are somewhat conflicting, the coal economy on local passenger traffic varying from *nil* up to 20 per cent. It would appear that the closer the stations are together, and the greater the number of stops in a given distance, the smaller may be the economy to be expected, all other things being equal. The all important condition to be fulfilled is the rapid generation of the superheat, and in order to effect this the Great Central Railway has tried a form of superheater similar to that used on the Continent for engines working stopping trains. Briefly, the apparatus simply consists of a larger number of elements than usual, the steam tubes being double loops of small diameter, housed within smoke tubes of 2½in. to 3in. in diameter, of which latter there are considerably more than when the smoke tubes are of the normal size of 5½in. The Great Central, in fact, has in some boilers used 3in. fire tubes throughout, with

a single superheater element in each tube. So far as this railway is concerned, however, no advantage in the matter of a more rapid rise in steam temparature, as compared with the ordinary large smoke tube type, has been noticed. Another factor that might be mentioned is the possible influence of driving wheel diameter, in connection with the time taken to fill and empty the cylinders after starting, with the resultant effect on the exhaust, and, therefore, on the fire. The smaller the wheel the more quickly will the beats follow each other, and the sooner, it might be argued, will the exhaust increase the draught through the fire-box, and the sooner will the desired degree of superheat be reached. The North Staffordshire tank engines, with 5ft. wheels, saved 20 per cent. in coal; the Great Northern, with 5ft. 8in. wheels, 18.7 per cent.; the Great Eastern engines, with 4ft. 10in. wheels, 3 per cent.; while the London, Brighton and South Coast express tank engines, with 6ft. 7½in. wheels, saved 15.4 per cent. The results, consequently, are not sufficiently conclusive in establishing a definite relationship between driving wheel diameter and economy, as determined by the more or less rapid attainment of the superheat.

In the case of main line locomotives, some additional economy is taken to accrue from the making of as full a use as possible of the expansive properties of the steam; that is, by notching up the valve gear to give a relatively short cut-off in the cylinders. On local traffic, especially where the stations are close together, and the time taken in covering the distance between each stop correspondingly short, there is not the same scope for linking up, and the engines are run with a comparatively late cut-off, primarily to enable them to accelerate quickly. As against this disadvantage, the later cut-off gives a stronger pull on the fire, due to the higher terminal pressure, so that the action of the exhaust under these conditions helps to raise and maintain the superheat, though not necessarily, *per se*, to the degree which is essential to the fullest, or any, economy, according to the frequency of the stops made. It is well known, in short, that the harder the engine is worked, and the later the cut-off, within limits, the greater will be the superheat. Hence, it would seem that the problem of invariably obtaining economy in coal consumption with superheater tank engines engaged on local or suburban work, requires further research, in view of the widely different results obtained. It would appear, all the same, that economy is possible.

The Control of the Speed and Power Factor of Induction Motors.

THE second lecture of the series on "The Control of the Speed and Power Factor of Induction Motors" was delivered by Professor Miles Walker at the headquarters of the Institution of Electrical Engineers on Monday, February 26th. Dealing with rheostatic control in the rotor circuit, the lecturer said that the connection of resistance with the rotor winding was only to be recommended when the change of speed was required occasionally or when the total drop in speed was so small that it was cheaper to waste the slip power than to turn it back into the system. The main cases where rheostatic control is employed were the following:—(1) In starting, where the total energy wasted in the starting bears a reasonably small proportion to the energy of the total run, as, for instance, where a motor has to be started up once a day. Haulage motors of medium size were sometimes arranged for rheostatic control and were reasonably efficient where the wind was a long one. For traction work where two induction motors were connected in cascade the control was virtually rheostatic and the cascade connection reduced the energy wasted in the resistance. (2) In fly-wheel motor generators where it was necessary to reduce the speed of the induction motor in order to allow the fly-wheel to give out its energy rheostatic control was often employed. Even motors directly coupled to rolling mills might be used with rheostatic control where a heavy fly-wheel was used to take the peak loads.

The simplest arrangement for fly-wheel motor generator sets, it was explained, was to put a permanent resistance in circuit with the rotor so as to give the required drop in speed at full load. This was not efficient because there was a greater waste of energy than there need be during the time when the fly-wheel was gaining speed and at light loads. Moreover, the load on the motor was not equalised. Another method was to arrange a number of automatic contactors so that they cut in resistance in steps as soon as the load on the motor reached a prescribed limit and so that they cut out steps as soon as the load fell below another prescribed limit.

Load diagrams for these two methods were exhibited. On a mill demand of 750 horse-power the constant resistance method gave a maximum demand of 480 horse-power, whereas the "notch back" contactor method did not call for more than 350 horse-power.

The most satisfactory rheostatic control for fly-wheel sets, Professor Walker stated, consisted of a continuously variable rheostat such as a liquid controller worked by a motor whose torque varied with the load on the motor.

A suitable rheostat, the lecturer said, consisted of three earthenware cylinders, one for each phase and containing an electrolyte. In each cylinder there was a plunger capable of being raised and lowered so as to increase or decrease the resistance between plunger and a conductor at the base of the cylinder. The plungers were operated by means of a counterpoised arm from the rotor of the motor magnet. The winding of the motor magnet was connected to the secondaries of series transformers; the primaries of these being in series with the stator of the induction motor to be controlled. Any increase of the load of the motor above a prescribed limit caused the motor magnet to lift the plungers and increase the resistance so that the current drawn by the motor was not excessive as the motor slowed down and energy was given up by the fly-wheel.

In the weir type liquid rheostat the depth of liquid between the electrodes is increased or diminished by the raising of a weir by the motor magnet.

The problem of changing the speed of an induction motor fed from generators on a ship, Professor Walker went on to explain, was simplified by reason of the fact that the speed and voltage of the generator could be altered at will. Some problems of interest had arisen in connection with the driving of battleships in which it is desired to provide two speeds, one for cruising and another for driving the ship at its highest attainable speed, the "fighting" speed. A very large number of solutions had been put forward for making the semi-permanent change in speed between cruising and fighting.

The method which had found most favour in the United States where a number of battleships had been fitted with electric propulsion was the method of pole changing.

The fighting speed was usually about 50 per cent. greater than the cruising speed, and required about 3.5 times as much power. It was, therefore, usual to arrange one turbine or one set of turbines for supplying the power on cruising and a greater number of turbines for the fighting speed. One of the requirements was that the induction motor should be capable of giving a very high torque when it was switched over from full speed ahead to full speed astern.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

RAILWAY SIGNALLING.

SIR,—In the Retford accident blame can apparently be attached to no one. The patchy nature of the fog leaves the question of calling out fog men a matter of locality and opinion, and the driver on not hearing his fog signals is entitled to assume, as you point out, that he has the road; in fact, it is probably only a man of experience that would have the nerve to "carry on" through such a station as Retford in the absence of positive confirmation, and if he had not been able to see his signals, and it is a pathetic feature of this accident that such should be the case. We are judged by results in this world, but for all that the conditions surrounding the Retford accident were those which might well have embodied a disaster of the first magnitude, and it is doubtful if they could be repeated with so small a death roll. Under these circumstances, it is reasonable to ask whether the risk of this class of accident may be materially reduced. There are three ways of doing it. (1) As you point out, by adopting automatic train control, which is, however, costly, and also, in the opinion of many, abolishes too completely the driver's responsibility; (2) repeat foot-plate signals, as recommended by your correspondent, Mr. J. Jackson; and, lastly, the still simpler and obvious method of appointing a pilot observer or look-out on all the "crack" trains. This man would not ride on the footplate, but, as at sea, would be isolated in a special look-out box and would have nothing but signals to watch. It would also be his business to communicate every observation, positive or negative, to the driver, and to obtain the driver's confirmation, just as the look-out at sea reports to the officer of the watch. The observers could well be drivers due for promotion, or might often be men at present pensioned by the companies for accidental mishap to a limb, for so long as his sight and intelligence is in order, no disability need fall upon him owing to the loss of a leg or an arm, and when engaged in such work, naturally his station would be in a shelter hut provided on the bogie. I am aware that many years ago *Punch* suggested the binding of a director to the boiler top as a wholesome preventative, but what *Punch* wrote in jest may reasonably be applied to-day in earnest without any very heavy outlay of capital and to the great increase of safety of the travelling public, who has a right to expect that preventable accidents shall be eliminated more completely than has recently been the case.

Bawtry, Yorks., March 5th. S. P. CHRISTIE.

WHAT DO EMPLOYERS WANT?

SIR,—During the past twelve months I have replied to a large number of advertisements in your and other papers, and have scarcely ever received a reply, although I am sure my qualifications must be equal, if not superior, to those actually required by some of the advertisers. As an associate member of the Institution of Civil Engineers, my training, both in theory and practice, cannot be denied, owing to the strict method of election to corporate membership of the Institution, and I have never asked anything but a most reasonable salary; in fact, I think in some cases too low.

It would at least do no harm if employers would acknowledge receipt of letters applying for posts, as one is often at a loss to know the reason why an application has not been successful, whether too high a salary has been asked or whether a man with qualifications and training coinciding more nearly with requirements has been found, because I think whatever post is vacant it is very doubtful whether an applicant is ever found whose experience exactly coincides with what is required.

March 2nd. A.M. INST. C.E.

A WARNING TO INVENTORS.

SIR,—We were interested to read in your issue of February 16th a letter from Captain G. Drury Coleman, organising secretary of the Institute of Patentees, with which he enclosed a copy of a circular letter received from a German correspondent in Bonn. This company received a similar communication from the same German source, and a second communication in the form of a post-card has now come to hand.

FERRANTI LIMITED.

Hollinwood, Lancashire, March 3rd.

Proposed Second Isthmian Canal.

AGITATION prevails among certain of the Central American States regarding the Nicaraguan Canal project, which, after lying long dormant, has been actively revived. Four out of the six States concerned have at various times protested against any second isthmian waterway being constructed and exclusively owned by the United States. Honduras and El Salvador particularly feel that they would be adversely affected by the construction; while all, with the exception of Panama, claim that a North American coaling station established at Fonseca Bay, which not only touches Nicaragua, but also Honduras and El Salvador, would curtail the sovereignty of these republics and prove a possible menace to their autonomy. They point out further that while the Panama Canal has brought them no additional commercial prosperity, as was promised, any advantages to be derived from the cutting of a canal through Nicaraguan territory cannot be accurately gauged, nor can any commercial prosperity attend Nicaragua itself unless more activity is to be displayed in the development of its resources, for which no provision is made in the United States Treaty.

On the other hand, it is freely recognised that from the building of this waterway undoubted advantages would accrue to the United States as forming an adjunct, and not a rival, to the Panama Canal, which has now become so congested with freights passing from the Colon to the Balboa side of the isthmus that vessels in transit can no longer be handled with sufficient expedition.

The conception of the Nicaragua route dates from 1838, when one Aaron Clerk, Mayor of New York, memorialised Congress in the interest of a waterway planned to connect the Atlantic and Pacific oceans. Among others who recommended the adoption of this route was John L. Stephens, deputed by President Van Buren to report on the project; while John Bailey, an engineer, was sent out by an English company to survey the Nicaraguan route and negotiate for a concession. The latter advocated a route extending from San Juan—now Greytown—to Lake Nicaragua, across the lake to Lajas, and thence to San Juan-del-Sur on the Pacific. The right of transit across the isthmus of Panama was finally secured in 1848, while that across Nicaragua followed a few years later.

An alternative route, upon which construction was decided but never proceeded with, called for the cutting of a ship canal from Greytown to any point on the Pacific by way of the San Juan River, Lake Nicaragua, and the Tipitapa River, or any other waters within Nicaragua's jurisdiction.

In December, 1884, a treaty was negotiated between the United States and Nicaragua for a canal to be owned by the two contracting parties. This treaty was afterwards withdrawn and a concession was granted, in 1887, to Señor A. G. Menocal for the building of a ship canal from Greytown to Brito. As the canal would affect Costa Rican territory, the consent of that State had to be sought, and was obtained. A similar concession was secured in 1888. Work upon construction was actually commenced in October, 1889, but suspended in 1893. It was not until 1913 that the United States, through their Minister to Nicaragua, negotiated a contract with that republic to build an inter-oceanic canal across the isthmus by one or two alternative routes. Both Costa Rica and Honduras protested against the treaty, which, however, was carried through. The contract was at first, in March, 1915, refused endorsement by the United States Senate Committee on Foreign Relations, but in February of the following year the Senate ratified the treaty, thus enabling the United States not only to acquire the canal route in perpetuity—as in the case of Panama—but also the right to build a naval station on the Bay of Fonseca, together with the acquisition of Great Corn and Little Corn Islands, which, it was claimed, were necessary to protect the Panama Canal in time of war.

The United States undertook to pay Nicaragua an indemnity of 3,000,000 dollars (£600,000) "to be applied on national indebtedness or other public services with the advice of the United States Department of State." Similar terms, it is understood, have now been offered to Costa Rica upon condition of that republic withdrawing its objections; it is thought that the offer will be accepted. The republics of Guatemala, Honduras and El Salvador have still to be reckoned with. Although the subject does not appear upon the agenda, it is intended to raise the question of the Nicaraguan project, and to present objections against it, at the Pan-American Conference to be held at Santiago-de-Chile during the present month.

Sight is not lost either of the volcanic dangers attending the construction of a canal in this part of the world, which is so frequently subject to seismic disturbances. Geologists who have studied the matter have deemed it necessary to draw a distinction between the Lesser Antilles, which are mainly volcanic, and the Greater Antilles, to which the Danish Antilles belong. In the latter it is contended that there has been no manifestation of subterranean fire since man appeared on earth. In other words, while on the Isthmus of Panama there is little likelihood of volcanic activity, in Nicaragua it is always to be apprehended. Apart from physical disadvantages, however, the cost of maintenance and operation of a Nicaraguan waterway is expected to be higher than that at Panama. As designed, the former would have twenty-four locks instead of twelve, in pairs, as on the Panama Canal. The cost of the Nicaraguan route, originally estimated at £28,000,000, would to-day be nearly doubled, compared with £80,000,000 expended to date upon the Panama Canal.

ROYAL INSTITUTION.—A general meeting of the members of the Royal Institution was held on Monday afternoon, March 5th, Sir James Crichton-Browne, treasurer and vice-president, in the chair. The death of Professor Röntgen was reported to the meeting and a resolution of condolence with the family passed. The Countess of Winchelsea, Maharaj Kumar Rajendra Singh, of Jhalawar, Dr. Cecil Birt, Miss Elinor Busk, Mrs. A. F. C. Freeman, Mrs. Norah Gribble, Miss M. M. Grimes, Mr. G. P. Moyles, Dr. Nathan Raw, Mrs. J. A. Robinson, Miss T. C Trench, and Mr. A. G. Watkins were elected members.

A Seven-Day Journal.

The London Terminal Aerodrome.

FOR some considerable time attention has been devoted in aeronautical circles to the desirability of moving the London terminal aerodrome from its present site at Croydon to some other more convenient situation. The Civil Aviation Advisory Board has had the matter under close consideration, and has now submitted a report to the Secretary for Air. It has come to the conclusion that of the two other existing aerodromes near London that at Cricklewood would not be suitable for heavy traffic by reason of the up-hill "take off" which it has in one direction. The Hendon Aerodrome is more suitable, but as it is not likely to be built over in the immediate future, the committee recommends that it should not be purchased for the present but regarded as a reserve aerodrome. Twelve sites for new aerodromes were considered, but only two are specially mentioned in the report, namely, those at Gunnersbury Park and at Wormwood Scrubbs. To clear the first named area and erect the necessary buildings would cost, it is estimated, about £500,000. The second named site would involve an expenditure of hardly less a sum, and is on the small side. The proposal to form an aerodrome by roofing over one of the London railway termini is noted in the report. It is rejected as impracticable for the present, but is not to be lost sight of. The final conclusion arrived at is that the best method of improving London's aerodrome facilities is to enlarge the Croydon ground and extend the building accommodation thereon at an estimated expense of £225,000, and to acquire the Gunnersbury site with a view to its possible use in the future as an aerodrome.

An Anglo-Scottish Fusion.

IT is announced that an exchange of shares has been effected between Swan, Hunter and Wigham Richardson, Limited, and John G. Kincaid and Co., Limited, of Greenock. Messrs. Kincaid own the Clyde Foundry and Engine Works, and were established in 1868. The firm's capital is £750,000, and its workpeople number in normal times about 2500. The output consists of marine engines and boilers of all types and sizes, the annual capacity being about 70,000 indicated horse-power. Swan Hunter were established in 1860, have a capital of £9,000,000, and employ normally about 20,000 workpeople. The company has already a connection with the Clyde by virtue of the interest which it acquired in June last year in the North British Diesel Engine Works (1922), Limited.

Cornish Radium.

ACCORDING to a West Country newspaper, the output of uranium ore from the South Terras Mine in the Fal Valley, Cornwall, is now being treated for the recovery of radium direct at the mine head, instead of being, as formerly, crushed and shipped to France, where a separate company owning works near Paris undertook the extraction of the radium. Long before the Curies made their historic discovery the South Terras uranium ore—pitchblende—was mined and exported, principally to Germany for the manufacture of luminous paint. It is recorded that at one time it was even used, locally, for the building of houses. With the war the export business came to an end, and subsequently, on endeavouring to resume it, the company owning the mine, the Société Industrielle du Radium, found the cost of freights excessive, while if the radium extracted from the ore were brought back to this country, it would be subjected to a duty of 33⅓ per cent. *ad valorem*. It was, therefore, decided to undertake the extraction at the mine. The necessary plant was completed in January, and work was begun early in February. The processes involved are, however, lengthy and expensive, and it is anticipated that several weeks will yet elapse before the first sample of pure radium bromide is produced. The capacity of the plant is given as between 300 and 400 milligrams a month. The present selling price of radium bromide is £11 per milligram. The Colorado mines have now practically ceased to produce radium, and although there are said to be huge deposits of radium-bearing ore in the Belgian Congo, it is believed that a ready market will be found for all the radium that may be produced, and that other Cornish pitchblende mines, such as the Tolgarrick mine, may expect to receive a new lease of life.

Gasworks Explosion at Birmingham.

AN alarming explosion occurred on Sunday morning at the Birmingham Corporation's Saltley gasworks, as a result of which fifteen men were injured, three of them seriously. The explosion was very violent, and was accompanied by a huge tongue of flame, which quickly set fire to a wooden cooling tower. It occurred in the Mond gas plant section. The main connected to this plant was being cleaned at the time, the operation having been in progress since the previous day. Although the exact cause of the explosion has not yet been completely determined, it is believed to have been due to the spontaneous combustion of finely-divided particles of carbon in the main. It is obvious that a close investigation of the facts of the case is called for, since without doubt, if the tentative explanation advanced is correct—and the analogy with a coal-dust explosion in the Eskmeals experimental gallery predisposes us to believe that that explanation may be correct—other mains at other gasworks may conceivably be in a condition similar to that which led to the accident at the Saltley Works. If it should be established that precautions are necessary in the opening up of a gas main, the basis of the treatment required seems to be indicated by the results achieved at Eskmeals with stone dusting.

L.C.C. Tramways and German Rails.

LIKE other public bodies recently, for example, the authorities at Glasgow, Edinburgh, and Hull, the London County Council has had to decide whether it should accept low-priced foreign tenders for tramway material or pay more money and retain the work in the country. It is requiring a supply of track rails and fastenings, totalling 3300 tons, over a period of six months, or alternatively 4900 tons over twelve months. Of the tenders received the lowest figures were quoted by the Phœnix Works—Otto Wolff and Co.—of Cologne, the prices asked being £28,376 and £41,919 for the smaller and larger quantities respectively. The North-Eastern Steel Company, of Middlesbrough, quoted £39,370 and £58,351; and the Cargo Fleet Iron Company, also of Middlesbrough, £47,910 and £71,034. In all three cases it may be noted the ratio of the larger to the smaller sum quoted is exactly equal to the ratio of the larger to the smaller quantity, a fact which seems to indicate that British and German steel works regard the outlook for the future similarly, although, as we know, the respective conditions are far from being the same. At the meeting of the Council on Tuesday, the Highways Committee, with the concurrence of the General Purposes Committee, reported that it had decided to accept the tender of the North-Eastern Steel Company for the larger amount.

A London-Birmingham Motor Road.

ON the authority of a provincial newspaper we have it that plans are being prepared for the construction of an entirely new road between London and Birmingham for the exclusive use of mechanically-propelled vehicles for the carriage of goods and fast passenger traffic. The road would be of concrete, 50ft. in width and 91 miles long, and including land, bridges, and so on, would involve an estimated capital expenditure of £6,500,000. It would have no gradients steeper than 1 in 40, and no curve of less radius than one quarter of a mile. The work would be undertaken by private enterprise, and income would be derived from a toll levied on the vehicles using the road on a tonnage basis. It is claimed that the use of the road would save 20 to 35 per cent. transport charges. The road would touch Aylesbury, Banbury, Leamington, Dudley, West Bromwich, Smethwick, Walsall, Wolverhampton, and Coventry, and would probably ultimately be extended to afford communication with Manchester and Liverpool. No information, we understand, has so far reached the Ministry of Transport regarding this project, but it is stated that there is no reason why a private company should not acquire land for the purpose of constructing such a road.

Imperial Wireless Communications.

THE announcement made by Mr. Bonar Law in the House of Commons on Monday regarding the Government's policy in the matter of Imperial wireless communications, puts an end to a lengthy period of indecision and inactivity. Work on the Empire Wireless Chain was begun in 1913, but at the end of 1914 the Government cancelled its contract with the Marconi Company. Nothing was done in the matter during the war. Subsequently a committee was appointed to consider the matter, and recommended that the Government, in conjunction with the Dominions, should own and operate a complete chain of wireless stations. Although this recommendation was adopted by the Government, delay occurred, and the Dominions entered into contracts for, or adopted the policy of, constructing independent stations capable of giving direct communication with Great Britain without intermediate links. The new policy recommended by the Imperial Communications Committee and approved by the Government is to permit private enterprise to participate in wireless telegraphy within the Empire. Licences are to be issued for the erection in this country of stations capable of communicating with the Dominions, Colonies, and foreign countries. In addition, as a measure of national security, it has been decided that a Government-owned station communicating with the Dominions shall be erected in this country at the earliest moment. This Government station, it is proposed, should be available for commercial as well as service messages, so that in effect it would compete with the proposed privately-owned stations. If the new policy is given full effect, it is generally agreed that within two years from now this country will possess the most efficient wireless system in the world.

Accidents in Shipyards.

REPLYING to Mr. Trevelyan, the member for Central Newcastle, the Home Secretary on Tuesday gave figures showing the reported number of accidents, fatal and otherwise, in British shipbuilding and ship-repairing yards. In the three years 1912, 1913, and 1914, the numbers were 15,863, 17,736, and 16,547. Figures for the years 1915–1919 are not available, but in 1920 the number of accidents was 15,452; in 1921, 11,447; and in 1922, excluding Irish yards in this case, 7744. The figures very clearly reflect the state of activity prevailing in the yards. In view of the serious number of accidents in the industry, the Home Secretary is considering the desirability of instituting a special investigation into the means necessary to secure a higher standard of safety.

Patent Fuel and Road Tarring.

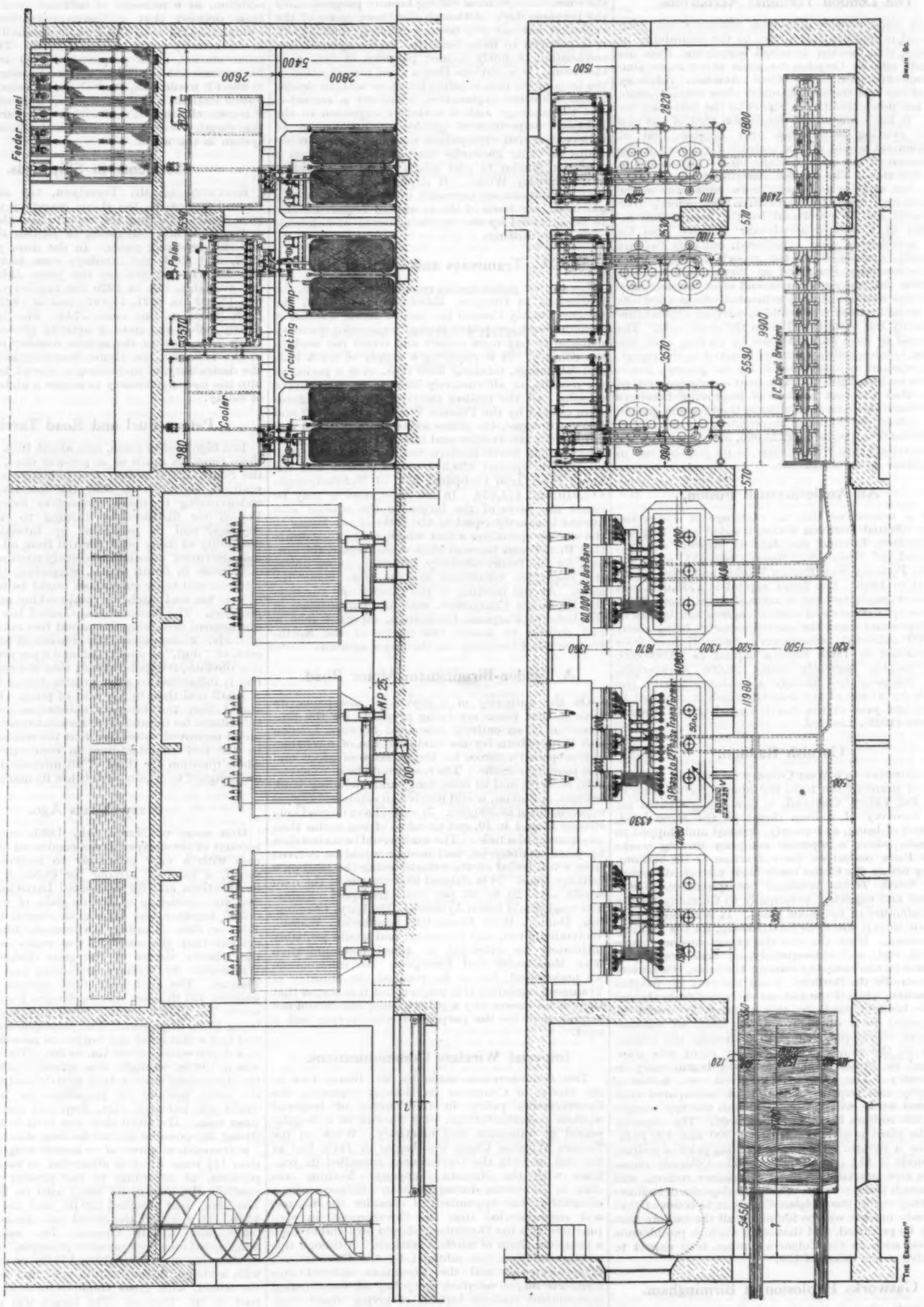
THE high cost of pitch, now about 165s. per ton, or three times as much as in pre-war days, has placed the South Wales patent fuel industry in a difficult position, so much so that the manufacturers are endeavouring to make themselves independent of British tar distillers by turning to America for supplies, and in particular by investigating the possibility of using pitch derived from oil. The local manufacturers' association recently circularised public authorities in South Wales, suggesting that natural bitumen and other substances might be used instead of coal tar and pitch for road-making and spraying purposes. The National Gas Council has now issued a statement criticising the patent fuel manufacturers' attitude. Since patent fuel consists of about 92 per cent. of "duff," or small coal, and 8 per cent. of pitch, it is obvious, it is pointed out, that the cost of patent fuel is influenced to a far greater extent by the cost of small coal than by the cost of pitch. It is further stated that the bitumen substances suggested as substitutes for tar and pitch for road-making purposes are of unproved value, and that the methods adopted by the fuel manufacturers in connection with the whole question are those of an interested trade, and are designed to obtain pitch below its market value.

Sixty Years Ago.

OUR issue of March 6th, 1863, contained an account of some experiments conducted at Shoeburyness with a view ostensibly to testing the Inglis shield, a form of armour for exposed portions of fortifications and for casemated batteries facing the sea, and consisting of double slabs of wrought iron bolted together and having an overall thickness of 12in. or 13in. Reading between the lines, it seems evident that the occasion was really used to test the relative merits of the guns designed by Mr. Whitworth, Sir William Armstrong and Mr. Lynall Thomas. The first shot fired against the shield weighed 137 lb., and was discharged from the Whitworth 7in. muzzle-loading rifled gun, the propellant being 25 lb. of powder. The projectile was hardened and had a flat head and buried its nose in the shield to a depth estimated at 4in. to 5in. The second shot was a 100 lb. wrought iron sphere discharged from the Armstrong smooth-bore muzzle-loading gun with the same amount of propellant as before. The shield was indented 2¼in. deep and cracked on the inner side. The third shot was fired from the Armstrong 300-pounder muzzle-loading shunt rifled gun, "a tremendous piece of ordnance weighing no less than 11¾ tons, which is altogether so vast in its proportions, as according to our present notions, to preclude the idea of its being used on board ship." The shot used weighed 230 lb. and the propellant 45 lb. It indented the shield and cracked an outer plate. Mr. Lynall Thomas' 7in. muzzle-loading gun," rifled on a very peculiar principle," and capable of throwing a shot weighing 150 lb. or even 200 lb., with a charge of only 25 lb., was next tried against the shield, with great trepidation, however, on the part of Mr. Thomas. The target was shaken and indented. The Whitworth and the Armstrong guns were again fired at the shield, and finally the Thomas gun was for the second time directed against it. On this occasion the inventor's fears were justified. It had, to his knowledge, been overbored in the breech, and when fired "burst into fragments like a gigantic shell," without, however, injuring anyone. The shield was declared the victor of the day.

THE PAU POWER-RECTIFIER SUB-STATION ON THE MIDI RAILWAY

(For description see opposite page.)



Modern Power Rectifiers.

On Friday, March 2nd, Mr. R. L. Morrison, of Power Rectifiers, Limited, delivered an interesting lecture on "High-power Mercury Arc Rectifiers, with special reference to Traction Service," before the Electrical Power Engineers' Association at the Institution of Electrical Engineers' headquarters. Having referred to the field which is open for a static alternating-current to direct-current converter that could be compared, from the point of view of simplicity, with the ordinary static transformer, and to the rapid progress which power rectifiers have made, Mr. Morrison then dealt with fundamental principles and the question of efficiency. Under all conditions of pressure and load, the lecturer explained, the efficiency of the rectifier is constant, for the drop in the arc remains constant under all conditions, and may be taken at between 20 and 22 volts, which is the pressure required to maintain the arc. This value is made up of three partial drops due to the two electrodes and the arc itself. The actual watts dissipated, therefore, are represented by the total drop multiplied by the current for any particular load which gives a constant efficiency under all conditions. Thus, when operating at a direct-current pressure of 1500 volts, the efficiency at all loads is represented by $\frac{1500}{1500 + 22} \times 100 = 98.6$ per cent. By adding the losses occurring in the main transformer and auxiliaries the true commercial efficiency is obtained. For a 1000-kilowatt set at the pressure mentioned this efficiency, Mr. Morrison explained, is about 96 per cent. at full load and about 93 per cent. at quarter load. Down to half load the figure is practically the same as at full load, it being only from half to quarter load that the efficiency curve drops a little, but even then the efficiency is extremely good, and the rectifier is therefore particularly suitable for traction conditions involving an average low load. With a lower direct-current pressure, say, 600 volts, the rectifier efficiency would be 96.8 with an overall efficiency proportionately lower.

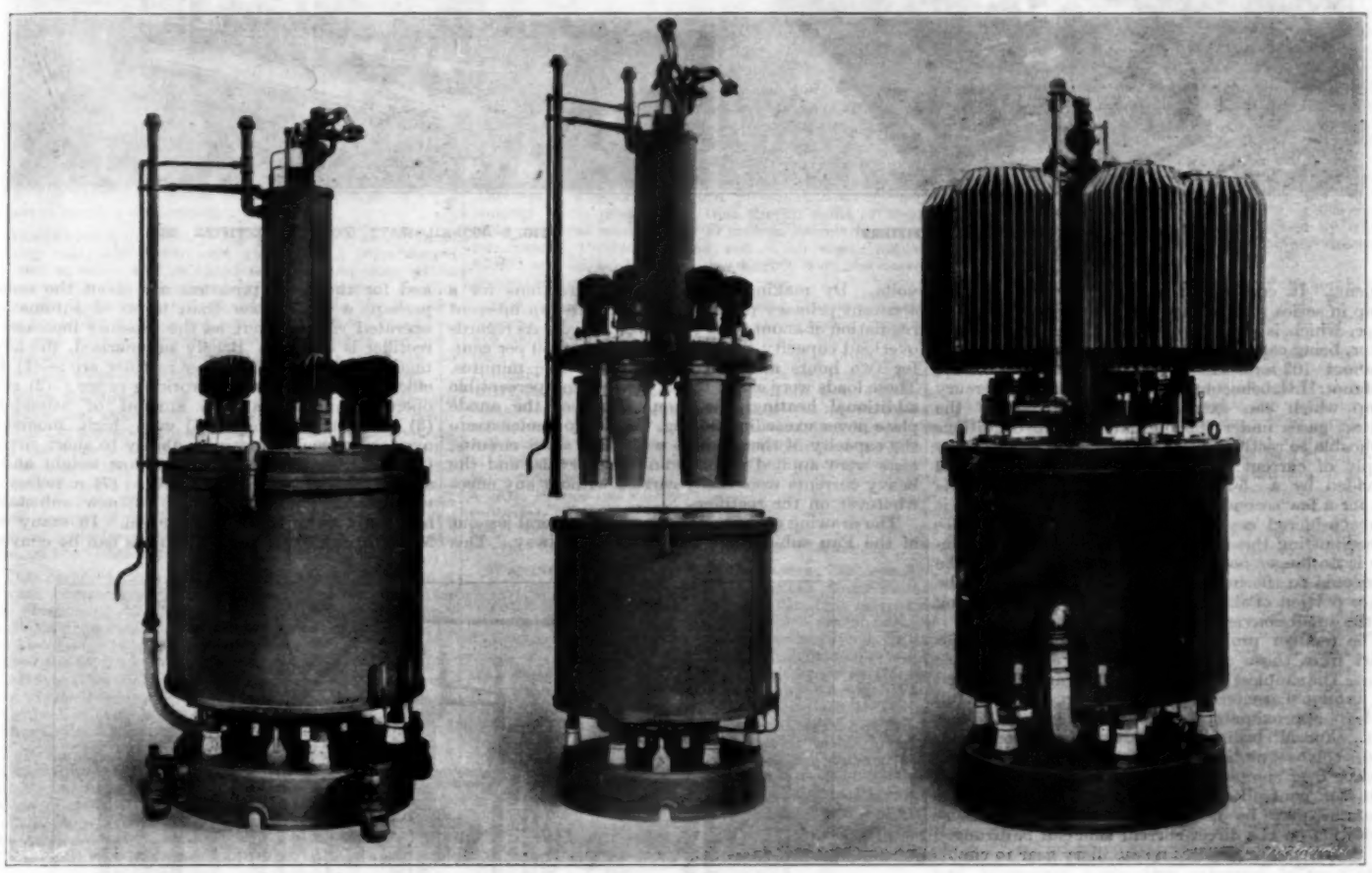
In dealing with single and polyphase rectifiers, Mr. Morrison explained that by inserting a reactance in the direct-current circuit of a single-phase rectifier the wave is prolonged and the undulations in the current are sufficiently reduced to make the rectifier work in a perfectly satisfactory manner. In its commercial form the large single-phase rectifier is provided with six anodes, which are arranged in two sets of three connected in parallel, and to ensure that the current divides equally between all the anodes an equalising reactance coil is placed in the anode circuits. Of course, rectifiers are usually employed on three-phase systems, and a very marked improvement in the wave form then results by the use of six and twelve-phase rectifiers. In the case of the rectifiers which have been installed in some of the sub-stations on the Midi Railway—see page 258—three to twelve-phase transformers are employed. Usually, however, the six-phase connection is adopted because it gives practically a straight-line wave, and the rectifier and transformer are more easily built. It is only in exceptional cases that the twelve-phase arrangement is chosen. The theoretical root mean square value of the phase current is equal to the root mean square value of the direct current divided by the square root of the number of phases, and for a six-phase rectifier the value is $\sqrt{6}$ or 2.45. The root mean square phase current for a rectifier giving a direct-current output of 1000 ampères would be $\frac{1000}{2.45}$, or 408 ampères. In practice, however, inductance is usually present, and the phase currents overlap. The value 2.45 usually becomes 2.8 or 3, which enables the transformer to be better utilised and the wave form to be flattened.

Coming to the kilovolt-ampère rating of the transformer, Mr. Morrison explained that by reason of the unfavourable utilisation of the secondary winding, which necessitates a larger amount of copper than usual on account of the root mean square value of the current being very high as compared with the average value, the rating is always greater than the direct-current output of the rectifier. For the single-phase case this increase in size amounts to 50–100 per cent., whilst for six-phase current it is 55 per cent., and for twelve-phase 84 per cent. If eighteen phases were used the increase would amount to 112 per cent., and it will thus be seen that it is unwise to increase the number of phases beyond a certain limit, six phases being as a rule the best number to employ. On the primary side the star or delta connection can be used, but the secondary is always open, and the neutral point is brought out to form the negative pole of the direct-current system.

Referring to the construction of high-power rectifiers, Mr. Morrison explained that whilst the problems involved had proved to be very troublesome, all difficulties had now been overcome. The most serious trouble, which for some time could not be grappled with, was that of internal flashing over or "back-firing." To make the valve action possible the electrodes must operate at a certain temperature relative to each other, and if for any reason one of the iron electrodes became hot enough to emit electrons the valve effect would cease and the current would flow in both directions between it and the opposing anode. This flow of current would constitute an internal flash over. The trouble may arise from other causes, such as that of mercury condensing on the anodes in the form of drops, the use of unsuitable material in the manufacture of the electrodes, insufficient vacuum and unsuitable arc guidance. The most usual cause, it seems, is the use of unsuitable material, which leads to the sudden liberation of gases that temporarily destroy the vacuum on a portion of the anode surface, thus producing local overheating. On account, however, of the measures that are now adopted in the manufacture of these rectifiers, it is said to be almost impossible for the mercury to condense on the anodes. The back-firing trouble has received the closest attention from the designers of the apparatus, and as the result of latest researches the rectifiers that are now built are, Mr. Morrison said, for all intents and purposes, free from the trouble, provided the vacuum is maintained, which involves no difficulty.

For all practical purposes the stationary power rectifier is claimed to be as reliable as the static transformer, and there is no reason why it should not be left unattended. Automatic control gear can be fitted so that a sub-station equipped with these rectifiers can look after itself. For cooling purposes a small quantity of water is necessary, and that obtainable from the town mains is usually suitable. Having been passed through the cathode base and then through the jacketing round the large cylinder, the anode plate and the jacket surrounding the condensing cylinder, it then passes out to waste or to a special re-cooling system. For the ignition of the arc there is a push button switch which operates a solenoid at the top of the condensing cylinder and a long rod passing down the centre of the rectifier, which rod has at its end a small anode poised just above the mercury. The anode is rounded and highly polished so as to remove all irregularities which might be conducive to back-firing. In the construction of the rectifier and vacuum pump it is essential to use the best materials procurable. Extremely fine limits are worked to, and the workmanship is of the highest order. The low-tension rectifiers, which are made in three sizes, are capable of dealing with 300, 600 and 1000 ampères at pressures up to about 600 volts. For higher direct-current pressures that may still be considered to be on the lower scale, namely, up to, say, 800 volts, the current ratings may slightly vary. Two high-tension rectifiers are also being manufactured, one for pressures up to 3000 volts, and the other for pressures up to 5000 volts, the current rating in each case varying from 250 to 750 ampères according to the pressure. A high-tension rectifier is shown in Figs. 1 and 2, whilst Fig. 3 shows a low-tension rectifier capable of giving 1000 ampères. The large rectifiers have anode radiator coolers in which water circulates on the thermo-syphon principle, while the high-tension types have short stumpy cooling fins for the anodes, as shown in Figs. 1 and 2.

Two 415-kilowatt 460-volt sets installed in a sub-station at Battersea are shown in Fig. 4, whilst Fig. 5 shows a 1000-kilowatt 600-volt set in use at Zurich. Sixteen 1200-kilowatt 1575-volt sets, as shown in Fig. 6, have been manufactured for the Midi Railway in France, and the general lay-out of one of the



FIGS. 1 AND 2—3000-5000-VOLT RECTIFIER

FIG. 3—1000-AMPERE LOW-PRESSURE RECTIFIER

mercury vapour sub-stations on this railway is shown in the drawing on page 258. When direct current is produced at a pressure of 5000 volts this pressure can be provided by a single unit, but when a larger current is needed than that which is provided by a single cylinder, two or three cylinders are used in parallel in conjunction with a single transformer. The ideal arrangement, however, is to employ a separate transformer for each cylinder, but this naturally involves a heavier initial outlay.

The vacuum pump set, Mr. Morrison explained, is to be regarded as the most important auxiliary. The pump used is of special design, and is extremely efficient. It consists of a high vacuum mercury pump in series with a rotary oil-immersed pump, the latter, which is directly coupled to a ½ horse-power motor, being capable of creating a vacuum equivalent to about .02 mm. H.G., the primary reduction to .001 mm. H.G. being obtained by means of the mercury pump which can extract large quantities of the lightest gases under the normal pressure conditions applicable to rectifiers. To start the arc an auxiliary supply of current is necessary, and this current is provided by a .5-kilowatt converter set, which is run for a few seconds when required. At one time it was considered essential to heat up the electrodes before putting these rectifiers on load, but this practice is no longer necessary, and the rectifiers can be connected to the bus-bars within a few seconds, the major portion of the time being occupied in running up the small converter set.

The rectifier proper has no regulating properties apart from those of its transformer and reactance coils. The simplest combination that can be provided has a shunt characteristic, the rise of pressure from full load to approximately no load being about 5 per cent. For all ordinary purposes, the makers contend, this regulation is close enough, but when level or over-compounding is necessary an induction regulator controlled by a Brown Boveri pressure regulator may be used. Any degree of pressure regulation on the direct-current side can be arranged for. The rectifier requires no auxiliary gear to enable it to parallel correctly with other converters, but when two or more rectifiers are fed from one main transformer paralleling reactance coils are connected in the anode circuits to ensure that each rectifier takes its proper share of the load. Separate panels control each rectifier, and on these panels the whole of the low-tension alternating-current and direct-current gear is mounted.

The power rectifier can be given any desired overload capacity, according to the continuous-current rating taken from any particular cylinder, the normal rating being based upon a 25 per cent. overload for 30 minutes, and 100 per cent. momentarily. Actually, however, the latter value can, when necessary, be several hundred per cent. Overloads are handled by these rectifiers without any indication of abnormal conditions existing, except, of course, the indications of the motors and the tripping of the circuit breakers. A curve exhibited by Mr. Morrison during the course of his lecture showed that on a test the normal current delivered by the rectifier was 400 ampères but the short-circuit current reached 8700, or about twenty-two times the normal current, before the switch opened. Such momentary currents, it was explained, have no effect on the rectifier, which can be switched in again immediately after the circuit has been broken. Sixty similar tests to the one just mentioned were made in two days, and on opening up the rectifier it was found that it was in practically the same condition as it was before the tests were made. The usual types of efficient circuit breakers may be used, although it is naturally advisable to employ breakers of the extra-rapid variety. Reverse-current trips are unnecessary.

During the course of his lecture Mr. Morrison exhibited a number of test curves showing the overall commercial efficiency of power rectifiers. In the case of the Midi Railway sets, the efficiency varies from 93.2 per cent. at quarter load to 95 per cent. at 50 per cent. overload, the guaranteed figures being 92 and 95 per cent. respectively. The power factor on overload was 96.5, at half load 90.5, and at quarter load 80.5. The regulation curve was also interesting. At very low loads on the direct-current side, *i.e.*, about 100 ampères and with a primary pressure of 7800, the direct-current pressure was 1680 volts, whilst at full load, *i.e.*, about 790 ampères it was 1598 volts, the primary pressure being 7650 volts. By making the necessary corrections for a constant primary pressure of 7800 volts, an inherent regulation of about 3 per cent. is obtained. As regards overload capacity the requirements were 50 per cent. for two hours and 200 per cent. for five minutes. These loads were easily taken without any perceptible additional heating, the temperature of the anode plate never exceeding 36 deg. Cent. To demonstrate the capacity of the plant to withstand short circuits, tests were applied at one-minute intervals, and the heavy currents were easily carried without any effect whatever on the rectifiers.

The drawing on page 258 shows the general lay-out of the Pau sub-station on the Midi Railway. This station contains three sets, each designed for a continuous output of 1200 kilowatts at a pressure of 1575 volts. It will be noticed that the rectifiers and their vacuum pump sets are surrounded by a substantial expanded metal screen because these parts are at a potential above earth, a little below that of the normal direct-current working pressure. This arrangement has been adopted in order to prevent attendants coming into accidental contact with the live parts, and wherever possible the doors giving access to the interior of the screen are electrically interlocked with the high-tension main switch so that they cannot be opened when the sets are under pressure.

As regards the initial cost of rectifier equipments, Mr. Morrison explained that it was somewhat higher than that of rotary converter equipments of equivalent size where direct-current pressures up to about 500 volts are concerned. But where the higher pressures of 1500 volts and upwards are used the rectifier prices are materially lower than those of the rotary converter. Even though under certain conditions the rectifier prices may be higher than the rotary prices, the advantages in the direction of low maintenance and attendance charges are considered to render the use of rectifiers desirable. The prices of completely automatic equipments of the usual size and for the usual pressures are about the same or perhaps a little lower than those of automatically operated rotaries, but as the pressure increases the rectifier is cheaper. Briefly summarised, the advantages claimed for the power rectifier are :—(1) High efficiency over the whole working range ; (2) simple operation and minimum amount of attendance ; (3) no synchronising ; (4) very high momentary overload capacity and insensibility to short circuits ; (5) negligible maintenance ; (6) low weight and the absence of special foundations ; (7) noiseless and vibrationless operation ; and (8) new sub-stations need only be of light construction. In many cases Mr. Morrison explained, old houses can be converted into sub-stations. The plant can often be erected in places that would be totally unsuited for rotating machinery, and a complete 240-kilowatt set has been erected in the basement of the North Metropolitan Company's showrooms at St. Albans.

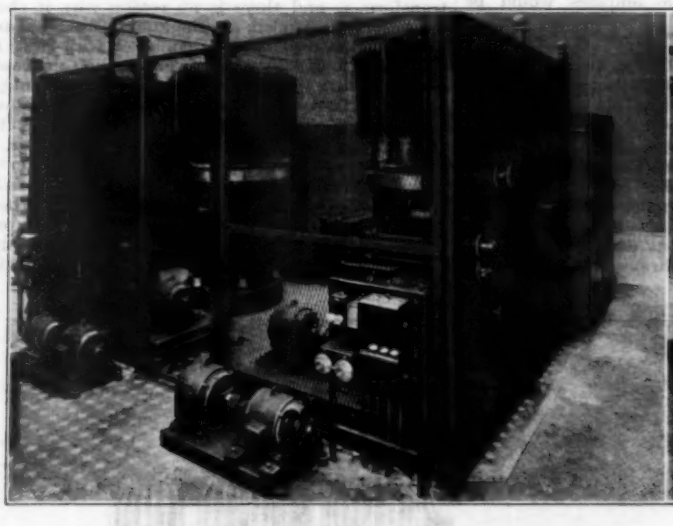


FIG. 4—415-KILOWATT 460-VOLT RECTIFIERS

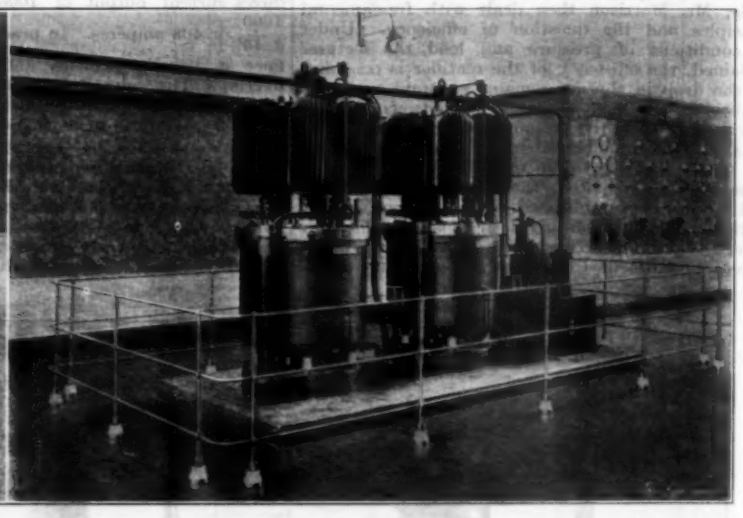


FIG. 5—1000-KILOWATT 600-VOLT RECTIFIER SET

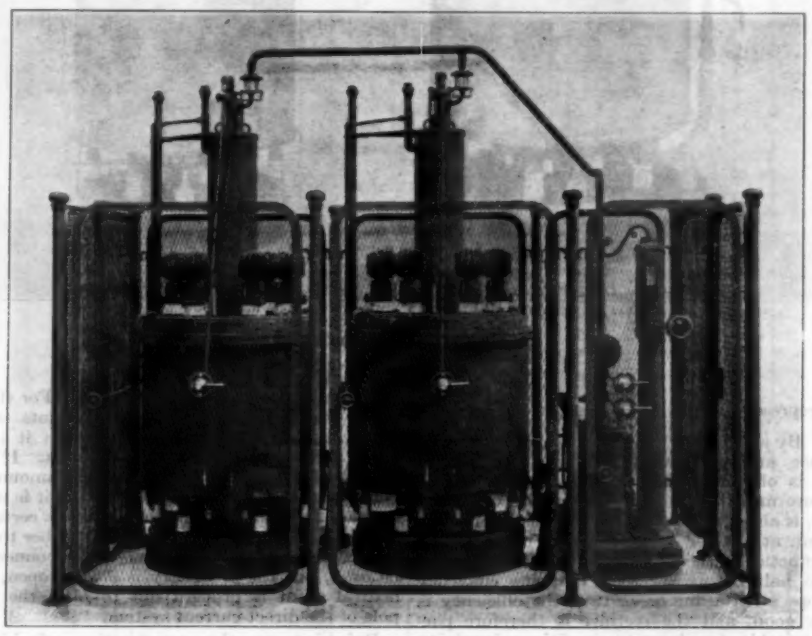


FIG. 6—1200-KILOWATT 1575-VOLT RECTIFIER SET

AMONG the items of capital expenditure during 1922 on the London and North-Western Railway were :—Ash-lifting plant, Camden and Crewe, £5270 ; mechanical coaling plant, Crewe, £2439 ; track circuiting at various places, £13,475 ; and Holyhead harbour improvements, £78,942.

Railway Matters.

THE Great Western station in Swansea is to be enlarged and improved.

DURING last year the Great Central Company spent £80,362 out of revenue on new locomotives and £29,873 out of capital on new wagons.

THE first company to use rail motor cars was the London and South-Western. In 1913 the line possessed twenty-six, but the last of them disappeared during 1922.

SPEAKING at the annual meeting of the Midland Railway, Sir Guy Granett said that coal had increased from 10s. 8½d. per ton in 1913 to 20s. 1½d. per ton; rails from £6 1s. 2d. per ton to £9 1s. 5d.; and the cost of relaying from £1420 per mile to £2680. Clothing now cost £135,823 as against £56,789, and stationery £146,786 instead of £74,199.

AT the North British Railway meeting on the 2nd inst., Mr. W. Whitelaw, the chairman, said that, speaking generally, he thought there was reason to anticipate that some reduction of rates might be possible in the near future, provided that there was no serious rise in the price of coal. But he hoped that what he was saying, and what had been said by chairmen at other railway meetings recently, would not lead to exaggerated hopes of wholesale reductions.

IN the February issue of *Swedish Export* it is stated that the Trollhättan Locomotive Works, of Nydgvist and Holm, have in hand a total of 500 locomotives of one and the same type, with a weight of 132 tons each. The company has lately acquired the Munktell Works in Eskilstuna, and the Lidköping Machine Tool Works, while the Forsbacka Steel Works has also been purchased to ensure a reliable supply of materials to the locomotive and other departments.

IT is officially announced that the directors of the London and North-Eastern Railway Company have made the following appointment:—Mr. H. N. Gresley, C.B.E., chief mechanical engineer, Great Northern section, to be chief mechanical engineer of the company with charge of the locomotive and carriage and wagon shops. It is proposed to transfer the working of locomotives from the chief mechanical engineer's department to a separate running department.

ANSWERING a question of the 22nd ult., Lieut.-Colonel Ashley said that there were twelve joint lines owned by two or more amalgamated railway companies which were outside the compulsory grouping scheme. Section 18 of the Railways Act, 1921, provided that the Minister may by Order confirm any agreement for the purchase, lease and working by one railway company of any part of the system of another railway company. He saw no reason for amending legislation.

WHEN the directors of the London and North-Eastern Railway met recently at Marylebone Station, the headquarters of the new company, they had sample locomotives and carriages from the constituent companies in order to determine the standard colours for the engines and exterior for the coaching stock. The passenger engines are to be of the Great Northern standard green, and the goods engines of the North-Eastern standard black. The coaches are to be of varnished teak similar to that hitherto used on the Great Northern.

THE Bishop's Castle Railway is a line belonging to a private company and running from Craven Arms, on the Shrewsbury and Hereford Joint Line, to Bishop's Castle, a distance of 10¼ miles. It has for years been in the hands of a receiver, a condition of things which prevented the taking over of the railway by the Government in 1914, and its inclusion in the Railways Act for absorption. It has been suggested that the Great Western should take the line over and the Ministry of Transport has the matter in hand with that company.

THE amalgamation of the North Staffordshire and Furness Railway companies has left Mr. F. A. L. Barnwell and Mr. L. Speakman, the respective general managers, unprovided for. Speaking of the former, Lord Anslow, the chairman, said what perhaps distressed them most was the future career of Mr. F. A. L. Barnwell, their very able general manager. He had youth, energy, foresight, courage, perseverance, tact and good temper. That he should be "out in the cold" when the new group would require all those qualifications at the new general managers elbow was incomprehensible to them who knew him and appreciated most highly his great abilities.

BECAUSE of the prominent part he has played in political affairs it is not generally known that Viscount Grey is a director of the London and North-Eastern Railway, and was, until the Campbell-Bannerman Government was formed at the end of 1905, the chairman of the North-Eastern Railway. Speaking on the 23rd ult., at a farewell dinner of that company, Viscount Grey referred to the expectations the public had been led to anticipate from the Railways Act. He observed that "The public have been taught to expect great economies. I should like to know how much praise we shall get if we proceed to run fewer trains. I am sure we shall not be able to make very large economies to begin with. In time I hope it may be possible, but a transition stage is always an expensive stage, and we have got to work through that stage before we can realise economies."

WORK has been commenced on the power station at Colenso for the electrification of the Natal railways. It will at first contain five Parsons turbo-alternators, space being left for the erection of a sixth set should it be required in the future. These alternators will have a normal capacity of 12,000 kilowatts and will be capable of carrying 15,000 kilowatts for short periods, and as much as 20,000 kilowatts for two minutes at a time, so as to cope with short periods when an unusually heavy demand is made on the power. This amount of power is to enable industries along the line to be supplied. Steam for the sets will be provided by eight Babcock marine type boilers, each capable of a normal evaporation of 50,000 lb. to 60,000 lb. of steam per hour. The boiler-house is being arranged with a special view to its ultimate utilisation for the production of by-products such as motor spirit, fuel oil, tar, &c. It is estimated that the erection of the power station will occupy two years.

Notes and Memoranda.

IN the course of a paper on Stainless Steel, read by Mr. J. H. G. Monypenny, before a meeting of the Birmingham Metallurgical Society, the author said that its resistance to corrosion was influenced to a considerable extent by the heat-treatment which the steel had undergone. The material had the greatest resistance to corrosion when hardened, and the least when annealed. Cold-work decreased the non-corrodibility to a considerable extent.

WRITING in the *Colliery Guardian* Professor Henry Briggs describes some promising experiments in the use of "Colloidal Oil" as a dust-laying material in coal mines. The material is a thin emulsion of bitumen and green oil in water. As supplied in 40 gallon barrels it is composed of 50 per cent. water and 50 per cent. bitumen and oil. Before being applied, the emulsion is considerably diluted with water. The method has, it is said, been found to be as safe as stone dusting.

THE floor of a concrete reservoir in a western American town started to crack before it was put in service, as the concrete had been laid in very hot weather, and it cooled down when the roof was put on. With the idea of accelerating the cracking and assuring that it had extended as far as was likely ice and salt were spread over the floor to a depth of 6in. When the slush had been drained away the cracks were opened out with chisels and a mastic composition filled into them.

IN discussing the tidal-power problem, Dr. Ing. Siemonsen comes to the conclusion—according to the *Iron and Coal Trades Review*—that under the most favourable conditions a kilowatt-hour might be obtained from the North Sea at an expenditure of 0.15 mark, whilst it can by other methods in some cases be obtained for 0.04 mark, pre-war prices being assumed. The calculations are made for the island of Husum, off Schleswig-Holstein, where the tidal range is 3.22 m. (just over 10ft. 6in.).

A RECENT decree of the Mexican Government renders it obligatory upon the part of the oil companies to instal machinery necessary for utilising petroleum gas, a waste product hitherto little used. While some of the companies have complied, others are still unable to obtain necessary machinery, adequate supplies of which appear to be lacking. It is pointed out that the oil wells of Mexico have produced more than 800 million barrels in the last ten years. Production has not diminished, between 65,000 and 70,000 barrels a day having been the average of the last few months of the past year.

IT is estimated that while the United States of America possess 2,000,000,000,000 tons of coal; Germany (pre-war), 410,000,000,000 tons; Great Britain, 190,000,000,000 tons; Russia, 60,000,000,000 tons; and Austria and Hungary, 44,000,000,000 tons; France has only a reserve of 17,000,000,000 tons. It is probable that the Saar basin alone contains more coal than all the known French coalfields. Moreover, it is possible that new discoveries will increase the resources of Germany, and particularly of Russia, whereas in France new discoveries are rare. With the normal pre-war consumption of 60,000,000 tons a year, France has sufficient coal to last for nearly three centuries. Even if the consumption were increased to 100,000,000 tons a year, the supplies would not be exhausted for nearly a century and three-quarters.

WRITING in our American contemporary, *The Iron Age*, Mr. P. M. Tyler says that at the moment Great Britain is the most favourably situated of all nations as regards fuel supply. Even ignoring all consideration of political disturbances and labour and transport conditions, British mines can undoubtedly produce coal much more cheaply than those in any other iron-making district in Europe, with the possible exception of the Ruhr district. While under normal conditions it is not likely that the cost of coal at the mines in Wales or England will be as low as the cost of mining coal from the thicker seams found in the United States, the fact that British coal and coke hardly ever have to be carried more than negligible distances from the mines and ovens to the blast furnaces and steel works does much towards equalising fuel costs in the iron and steel industries of the two countries.

A FEW years ago a discovery was made of extensive deposits of bauxite, or hydrated oxide of aluminium, in the interior of British Guiana, not far from Georgetown. Some shipments of the product were made to England and the United States in crude form, principally to supply the demand of the companies engaged in the production of metallic aluminium, although some of the material was used chemically to produce the various alums and other compounds. In 1917 the Aluminium Company of America, which, it is said, practically controls the United States market, secured a very large area of the bauxite formation, which includes, according to a report in the *Raw Materials Review*, a practically inexhaustible supply of the material. The company has been carrying on extensive investigations and developments, and is building a fleet of six steamships, which will be used exclusively in the transport of the material to Gulf ports and St. Louis, from which points it will be distributed to the company's plants.

IN the course of a paper read before the Manchester Section of the Institution of Rubber Industry, Mr. J. H. Mandelburg gave a brief account of a noval method, originated in America, for recovering volatile solvents. Flue gas, which might be cleaned by a washing or scrubbing process, was caused to flow in contact with the fabric to take up the vapourised solvent therefrom, and the resultant mixture of flue gas and solvent vapour was treated to separate one from the other. The flue gas was generated by burning any suitable kind of fuel, such as coal, coke, charcoal, wood, oil, or illuminating gas, in special burners or stoves. The sensible heat of the gases was practically wasted, and their use in commercial practice had hitherto been considered out of the question on that account. On the other hand, it had been demonstrated that the expense and economic waste of heat involved in the cooling and purification of the gases was justified because of the protection which their subsequent use afforded against fire and explosion. It was claimed that this apparatus was designed to recover all but a very small percentage of the solvent used in treating the fabric.

Miscellanea.

IT has been decided to revive the Birmingham and Midlands Section of the Institute of Chemistry, the existence of which had lapsed since the termination of the war.

A CABLE from Rangoon states that the Burma Government scheme to aid the tin industry, which came into force in February, 1921, has now terminated in consequence of the rise in the price of tin.

AN order approximately £350,000 in value from the Portuguese West African Government has been placed in England for track material. This order has since been supplemented by a further one, from the same source, for 350 kiloms. of track material, making the total value of the order £878,000.

IT is stated that the net profits of the Siemens and Halske Company for last year were 158,000,000 marks, as compared with 37,000,000 marks for the previous year, and that the dividend paid was 80 per cent., against 20 per cent. It is further stated that the net profit of the Siemens Schuckert Company was 103,000,000 marks, as compared with 22,000,000 marks, the dividend being 80 per cent., against 16 per cent.

THE falls of rain have improved or saved the situation in part of Spain, not including, however, Catalonia, where the drought continues and is causing considerable damage. The hydro-electric companies have informed the authorities that the level of water at the barrages has fallen to a disquieting extent, and that they calculate that they have sufficient water for only four or five weeks. The quantity of energy in question amounts to about 200,000 horse-power and if rain does not fall during the next few weeks serious industrial difficulties are likely to arise throughout the whole Catalonian region.

ACCORDING to a report in the *Sydney Morning Herald*, of January 10th, there was recently an interruption in the Sydney electricity supply for about twenty minutes, with intermittent interruptions from 8.20 a.m. to 9.35 a.m. The city electrical engineer, in his report, stated that "practically the only portion of the area supplied with electricity by the City Council in which there was not an interference with supply was the centre of the city, and in this portion the supply was maintained by using the storage batteries and the auxiliary supply drawn from the Railway Commissioners' system."

THE Committee on the Plan of New York and Environs, acting in co-operation with the Russell Sage Foundation, has appointed a group of city planners to make a preliminary study of the environs of the city. The area to be studied comprises about 5000 square miles and extends for a radius of from 30 to 50 miles from Manhattan. It has been divided into six sectors which have been allocated to the members of a group under the chairmanship of Mr. Thomas Adams, who will make a joint report on the opportunities and dangers in connection with the problems of the use and development of the land; communications; decentralisation of population and industries; and open spaces. The report is to be submitted before October 1st.

THE Brazilian Government has authorised extensions to the existing water supply of Rio de Janeiro, the cost of which is to be met by the Federal Treasury. The maximum expenditure allowed is 15,000 contos of reis (nominally £750,000). At the same time, authority has been given for the completion of the free port on the Ilho do Governador, in Rio de Janeiro Bay. Considerable difficulty has hitherto been experienced in getting the caissons into place, and owing to the shallowness of the water, a large amount of dredging will be necessary in preparing the approaches to the new docks. The dock system is also to be extended beyond the present line of wharves to the point of Caju. This undertaking is in the hands of the French Crédit Foncier, while the port works are entrusted to the firm of Lage Irmãos, owners of the Costeira Steamship Company, Rio de Janeiro, Brazil.

THE British Non-ferrous Metals Research Association has adopted an improved method of communicating the results of its research investigations to its members. Lectures are arranged at one or more centres to which, as a rule, only members of the Association are admitted. Two objects are served in this manner. Firstly, early confidential communications of the results of the research is assured to those who have given it financial support, and, secondly, the investigator gets into close and immediate contact with that section of the industry chiefly interested in his work. In this manner the future direction of work and the relative practical importance of its varied issues is subjected to the mutual consideration of researcher and the industry. The Association is at present engaged on some ten investigations, all of which are closely connected with different branches of the metals and engineering trades.

RECENTLY two 7500 kilovolt-ampère turbo-sets were in operation in the Corporation station at Oldham. In shutting down one of these sets, states the *Electrical Review*, the excitation was cut off and the machine speed increased in order that the machine might be tripped out by the emergency over-speed governor, as is usual practice when testing such emergency gear. When a speed slightly below 3300 revolutions per minute had been reached (the normal tripping speed of the emergency governor), the rotor opened out and jammed in the stator bore. The heat due to friction caused the oil from the bearings to catch fire, and it was necessary to call out the fire brigade to extinguish the flames. This was done in a few minutes. It was found that the cast iron frame surrounding the laminations had been fractured. The rotor shaft had been broken off at both ends and the ring of the stator laminations with the rotor inside had fallen into the pit below the machine. The generator foundations sustained some damage. The coupling bolts between the turbine and generator had been sheared off and a piece of the bearing housing cover on the turbine had been broken. The turbine, however, continued to run for several minutes after the accident. A piece of metal struck the emergency governor trip lever on the neighbouring set, which was running, and shut the machine down.

THE CENTRAL ELECTRIC GENERATING STATION AT COMINES

(*For description see page 249*)

FIG. 9—REINFORCED CONCRETE SHEET PILING FOR COAL DOCK

FIG. 10—COAL HANDLING TRANSPORTERS

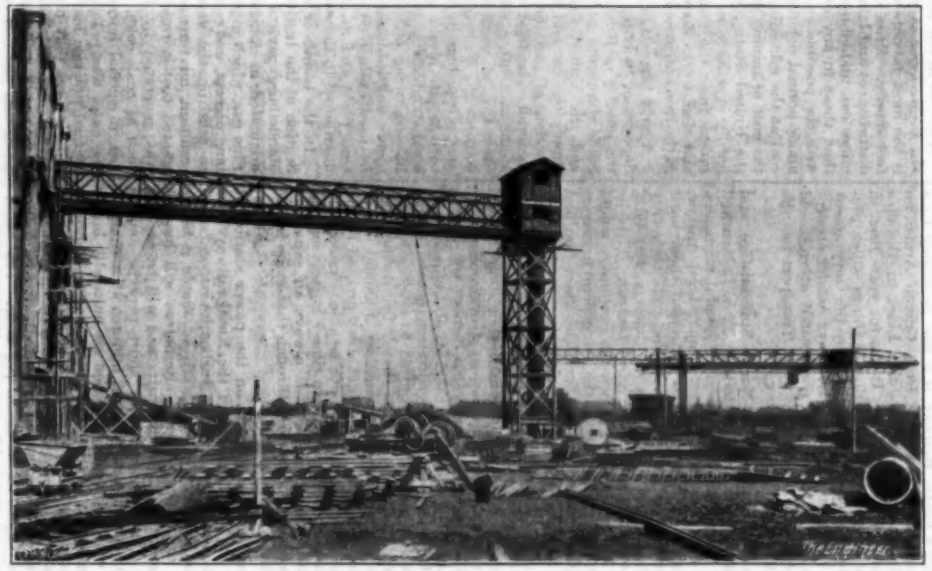


FIG. 11—COAL ELEVATOR TOWER AND CONVEYOR BRIDGE

FIG. 12—WORKMEN'S VILLAGE

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DEATH.

ON Saturday, February 24th, at Kirkstall Abbey House, Mr. A. EDMUND BUTLER, Chairman of Kirkstall Forge, Limited, and a former Lord Mayor of Leeds, in his 75th year.

THE ENGINEER.

MARCH 9, 1923.

The Railway Position.

WE have, on many occasions in the past, spoken of our railways as being administered by very capable men. The truth of this remark has never been better exemplified than in the results of last year's workings, which were far more satisfactory than they were expected to be. As the first seven and a-half months of 1921 were under Government control, no comparison between that year and last year can reasonably be made. Using, however, reports for the year 1913, we have compiled the instructive tables given on another page. They show that whilst the increases in rates and fares and in other charges have raised the receipts from railway working for the seventeen principal companies to 97.39 per cent. above those of 1913, yet the expenditure of the same companies was 150 per cent. more for the later year, and the ratio of expenditure to receipts had increased from 63.45 in 1913 to 80.44 in 1922. That, despite the concessions made to the men—made, be it remembered, by the Government or at its orders, and generally without the concurrence of the companies—and the high price of materials, coal, stores, &c., the companies have run the railways for roughly sixteen shillings out of every pound they received, and have four shillings left wherewith to pay interest on their capital and to put to reserve, is a result on which the country as much as the shareholders may be congratulated. The results become the more remarkable when it is remembered that the road and rolling stock have been brought again to their pre-war high standard. But some may wonder why, in these circumstances, reductions in rates and fares were small. We believe the answer to be that the signs of improving trade were not in the least definite, and are not even yet sufficiently strong to warrant great optimism. Moreover, until its terms for amalgamation or absorption definitely were secured, no company would do anything that would prejudice its financial standing. Especially was this so with those companies which contended that their position had been improved since 1913, the year on which the negotiations mainly were based. The opposition of these companies to any reduction was, in view of the inter-relation of all the companies, sufficient to spoil the good intentions of the others. The drop in passenger fares from roughly one penny three-farthings per mile to three-halfpence may seem small; but, as the passenger receipts in 1921 were seventy millions sterling, that reduction alone means a sacrifice of about eight millions a year. As the net receipts of the seventeen companies were less than two and a-half millions above the 1913 figure, the reductions in rates and fares already made would appear to indicate a highly optimistic spirit, and yet some of the chairmen have expressed hopes of making still further concessions.

In a second table given on another page we indicate the increases of 1922 over 1913 in the main items of expenditure of two typical companies—the Midland and the Great Northern—whose ratios of expenditure to receipts were 79.00 and 80.02 respectively, as compared with the average of 80.44 for the seventeen companies. It will be seen that the Midland had in 1922, as compared with 1913, a percentage increase of 165.99 in maintenance and renewal of way and works, of 143.33 in maintenance and renewal of rolling stock, of 174.25 in locomotive running wages, of 94.66 in fuel, of 130.33 in other running expenses, of 125.12 in traffic salaries and wages, and of 115.18 in other traffic expenses. The higher price of material had some effect upon the first two of these items, but to all of them the direct increase in the cost of labour contributed. It is the fact that any reduction in railway rates at once favourably affects the price of all commodities and manufactured material. This is a benefit the companies themselves enjoy, as they are large purchasers of materials and stores. Hence, a reduction in the cost of railway labour benefits the companies, and, through them, traders generally. Yet the railway unions reasonably may ask why should their members be made to take the lead in having their wages dropped. We invite them to turn back to December 6th, 1918, when Lord Ashfield, the then President of the Board of Trade, met them. He then not only promised the eight hours' day as from February 1st, 1919, but agreed that a new committee to deal with pay and conditions should forthwith be set up. Meetings were, as a consequence, held, by which many concessions over and above the eight hours' day were made to the men. These concessions were in the shape of a more liberal payment for overtime and Sunday duty, payment if called out for work and then not required, longer holidays, &c. All this was very generous, but the spirit prevailing at that time must be remembered. The Armistice was signed, hostilities were over and the enemy thoroughly beaten. Large reparations were talked of, and all were grateful to the men for the sacrifices they had made. But more had been promised than could economically be granted, and modifications of the National Agreement then concluded are now under discussion. The reductions are a real necessity. If the moderation hitherto shown by both sides be continued, we may expect the railway labour costs shortly to be further curtailed, with, as we have said, benefit not only to the companies, but, through them, to the traders and to the country as a whole. So much for the reduction of rates; but there remains another question of not less importance to the traders and the railways. We refer to the nature of the business relationship which exists between them. On the London, Midland and Scottish, for instance, there is one general manager, with a deputy general manager for Scotland; on the London and North-Eastern there is a chief general manager, a general manager for Scotland and two divisional general managers for England; on the Southern the *status quo* remains as yet, and there are three general managers—each, apparently, independent of the others. On the London, Midland and Scottish, and the London and North-Eastern, the arrangements for the civil engineer's and mechanical engineer's departments have now been settled. Herein, again, there has been no change with the Southern Railway. The fear that with such large companies touch with traders would be lost is intended to be met on the London and North-Eastern Railway by allowing the divisional general managers a very free hand. Thus, to quote Mr. Whitelaw, the chairman, traders will continue to enjoy their essential rights to have personal contact with a responsible officer in their own area and to discuss with him their difficulties and requirements. On the London, Midland and Scottish there are divisional men of high standing, under the chief general superintendent at Derby and the chief goods manager at Euston respectively. Undoubtedly, in this and other respects the Great Western is in the best position, as practically all the traders on the lines that company has taken over were already acquainted with the Great Western officers and their methods. At the annual meeting on the 22nd ult., it was said that the old form of departmental organisation had been pre-

served; the only new feature was the formation of a docks department under Mr. J. H. Vickery, the late general manager of the Alexandra (Newport) Docks and Railway. Whilst, then, it remains to be seen how all the details of amalgamation work out in practice, it is already plain that the companies, recognising the high value of the personal touch which existed between their local representatives and traders, will do their best to preserve it. It is certain that if that touch is lost, if the man with local knowledge of both persons and affairs is submerged in a soulless organisation, there will be perpetual trouble between the railways and the traders.

From this very brief review of the railway position and from the two tables to which we have already made reference, it will be seen that the railways have entered upon their first year under the group system in better circumstances than were expected. But the fact remains that rates are still a great deal too high and continual pressure will be necessary to bring about their reduction. Grouping will have achieved nothing at all, it will be no more than the realisation of a costly ideal of organisation, if it does not lead to economies of an order considerably in advance of those which we might fairly have expected under the old competitive system. The companies are now relieved of the cost of competition, and in return for that relief the country expects an improvement in transport facilities and a rapidly diminishing cost of transport. If it does not get these things, no excuses that its protagonists can make will save the grouping system from public condemnation.

Power Rectifiers.

The application of the mercury vapour rectifier to traction service and to other kinds of heavy electrical work is, to say the least, an interesting development. For years past the conversion of alternating current into direct current on anything approaching a large scale has necessitated the employment of revolving machinery, although it has long been apparent that a different method might ultimately be found. The small glass bulb mercury vapour rectifier, with which all electrical engineers are familiar, has proved invaluable for charging cells and work of a kindred nature, but the production of large rectifiers of this kind has been anything but an easy and straightforward task. The fact, however, that the aggregate capacity of power rectifiers now amounts to 105,000 kilowatts is a pretty clear indication that those who set out to grapple with the problems involved have done something more than merely carry out experiments, and that power engineers are beginning to investigate the merits of this class of apparatus. Naturally enough, rotary converter builders, who have done excellent business in the manufacture of these machines in the past, and who see in the proposal to use 1500 volts on main lines, every prospect of big orders coming to them in the future, do not view the power rectifier in a very favourable light. Adverse criticism was, of course, to be expected, for all inventions that threaten to interfere with older and well-established schemes invariably meet with opposition.

Long before the large mercury vapour rectifier was thought of there were many squabbles over the question of conversion. When Mr. La Cour introduced his motor converter to meet the demand for a machine capable of operating satisfactorily on 50-cycle circuits, heated discussions took place on the relative merits of the two machines concerned, and although it has now long been possible to make 600-volt rotary converters behave satisfactorily, when fed with 50-cycle current, the motor converter is, nevertheless, still favoured by some electrical engineers. Like most other new electrical contrivances associated with the generation and conversion of electric current, the mercury vapour rectifier has given trouble. Plenty of trouble was, however, experienced when rotary converters were first introduced. Even to this day electrical designers have not succeeded in making rotaries which can run with 50-cycle current and supply current to the track at a pressure of more than 1500 volts. Indeed, some designers seem to consider that even for this pressure two rotary converters should be connected in series. The inability to build rotaries for more than 1500 volts is no doubt the main reason for the proposal to standardise this pressure for traction work, for although it is true that motor generators can be built for higher voltages, these machines are appreciably less efficient than rotary converters, and also more costly. It is on this account, we think, that no one has as yet seriously suggested that 3000-volt direct-current traction should be adopted in this country. But the introduction of the power rectifier has somewhat altered the situation. As will be seen from Mr. R. L. Morrison's recent lecture delivered before the Electrical Power Engineers' Association, with which we deal elsewhere in this issue, these rectifiers can apparently be made without difficulty for a pressure of 5000 volts or even more, irrespective of periodicity, so that so far as conversion is concerned, there is no longer any need to limit the pressure of direct current lines to 1500 volts. But it is, of course, to be remembered that the production of high-pressure current is not the only matter to be considered. Having obtained such current, the electrical engineer is faced with the problem of how he can use it, for unfortunately there is no such thing as a static direct-current transformer. Whatever pressure is applied to the track of a direct-current railway must of necessity be applied to the motors, whereas with the single-phase alternating-current system, the overhead line and train equipment pressures may be very different.

Still, there seems to be little question that the power rectifier will, if it is considered desirable to work British main lines with direct current, enable a considerably higher pressure than 1500 volts to be used. Experience on the Chicago, Milwaukee and St. Paul Railway shows that the application of 3000 volts to the electrical equipment of locomotives is quite practicable. Motors have, moreover, been built on the Continent for 2000 volts, so that by connecting two in series a track pressure of 4000 volts can be adopted. We scarcely need dwell upon the inherent advantages of a high track pressure, such as the relatively small currents to be supplied to the line and collected by the locomotives or motor coaches, the wider spacing of sub-stations and the consequent reduction in the number of sub-stations needed. By far the highest track pressures are permissible when use is made of single-phase alternating current, but the advent of the power rectifier has, nevertheless, made the direct-current system more suitable for long-distance work than it was when conversion could only be carried out with the aid of rotary converters.

Obituary.

JOHANN AUGUSTE DIEDRICH BORNEMANN.

The death occurred on the 23rd ult. of Mr. J. A. D. Bornemann, formerly and for many years the managing director of Ruston, Proctor and Co., Limited, and latterly of Ruston, Hornsby and Co., Limited,

J. A. D. BORNEMANN

Lincoln, Grantham, and Manchester. Mr. Bornemann was a Dutchman, born in Amsterdam in 1850. He began to earn his living at the age of fourteen as an office boy, and by dint of great perseverance he acquired an intimate knowledge of five European languages. In 1877 he applied for the position of foreign correspondent advertised by Ruston, Proctor and Co., Limited. His application was written in four languages, and met with success. Mr. Joseph Ruston soon discovered that Mr. Bornemann had exceptional business abilities, and he had not been at Lincoln more than eighteen months when he was deputed to travel abroad for the firm, visiting the whole of Europe, the North Coast of Africa, Egypt, Syria, Asia Minor, and the Near East. After sixteen years of foreign travel, Mr. Bornemann was appointed to succeed Mr. John Kent as managing director of the firm, a post which he filled with very marked skill until his retirement in 1919. During the twenty-three years that he was responsible for its affairs the company made very considerable progress. When he first took up the reins of managing directorship the number of persons employed by his firm was 1955, and the weekly wage bill about £2200. During the war the employees numbered 7600, and the weekly wage bill rose to £30,000.

Although he made no claims to engineering education or training, Mr. Bornemann's remarkable aptitude enabled him to acquire a very good judgment in mechanical matters. During the war he worked with untiring energy. Under his direction the firm carried out contracts for the Admiralty, War Office, Ministry of Munitions, the Air Board, the Department of Mechanical Transport, the Department of Railways and Roads, Inland Waterways and Docks, Food Production Department, and the Home Grown Timber Committee. The output included 17,000 service wagons, 13,500 machine gun mountings, 55,000 gun fittings, 500,000 bombs and shells, 30,000 submarine mines, 2000 paravanes, 3000 carriers for depth charges, 2750 complete aeroplanes, and over 4000 aero engines.

Mr. Bornemann remained on the Board of Directors until his death, which occurred after a few days illness at his home in Lincoln. He took a very active part for some years in the affairs of the Lincoln Chamber of Commerce. He was also a Justice of the Peace for the City, and for his war work was made a Companion of the Order of the British Empire.

Institute of Metals.

No. I.

The annual general meeting of the Institute of Metals was held in the House of the Institution of Mechanical Engineers on March 7th and 8th, under the presidency of Mr. Leonard Sumner.

The report of the Council for the past year was presented and adopted.

REPORT OF COUNCIL.

Despite the duration of a severe period of trade and general economic depression the membership has continued to increase, the number on the register on December 31st, 1922, being 1436, as compared with 1410 on December 31st, 1921. Though the membership has grown, the resulting increase of income has not kept pace with the expenditure, the "carry forward" being decreased from £404 14s. 8d. to £315 6s. 5d. By far the largest item of expenditure is that relating to the *Journal*—£2385 8s. 10d.—representing more than half of the entire receipts from subscriptions and entrance fees. The cost of the *Journal*, which averaged £600 per annum in the two last pre-war years, rose to £830 in 1917–18, £1615 in 1919–20, and to £2303 in 1920–21, when the subscription was increased to £3 3s. The expenditure for the current year is estimated to be no less than £2700. This is accounted for by the unusually large size of recent issues, the last of which included seventeen papers and covered 1010 pages. Special attention is being directed to this matter of the size and cost of the *Journal*.

There have been issued two further volumes of the *Journal*, Vol. XXVII. and Vol. XXVIII., the latter being unfortunately delayed in publication owing to labour troubles at the bookbinders. Whilst Vol. XXVII. was above the average size, with 621 pages and 35 plates, Vol. XXVIII., containing 1010 pages and 37 plates, constituted a volume of record size. The seventeen papers printed in the latter *Journal* covered 500 pages, the remainder of the book consisting of a much enlarged Abstracts Section. The Publication Committee during the year have paid particular attention to this latter section, arranging for an increase in the abstracting staff, and setting up a system of abstracting whereby practically the whole of the technical publications of the world that are likely to contain any matter of interest to the members come regularly within the purview of the abstractors. It is felt that the growth in completeness of the Abstracts Section, together with the full index thereto—this containing over 5000 entries in the case of Vol. XXVIII.—will be appreciated by the members.

After two years' work, a general index, covering Vols. I. to XXV. of the *Journal*, was issued in November. The index volume, which covers 490 pages and includes 20,000 entries, has been well received, many members writing appreciatively of its value, and already more than one-third of the 1000 copies printed have been sold. It is hoped that still more members will secure copies of the index, which is available to them at half price, namely, 13s. 3d. post free.

At the conclusion of the formal business the reading and discussion of papers was proceeded with. There were no less than twenty papers on the agenda, and in order to give time for a discussion of even a selected list it was necessary to hold four sessions.

The first paper taken was that by Dr. D. Aitchison, "The Mechanical Properties of the Magnesium Alloys," of which we give a brief summary.

MAGNESIUM ALLOYS.

Tests have been made upon Electron metal supplied by the Sterling Metal Company, and also upon various other alloys of magnesium which have been manufactured by the Magnesium Company, Limited. The materials have been tested in a variety of conditions. Some of the specimens were in the cast condition, some of them had been rolled into strip, others again had been extruded, whilst others were hot forged. The alloys contained only one element in addition to magnesium. The alloying elements were copper, aluminium in different proportions, and cadmium. This statement does not refer to the Electron metal, which was not analysed.

The cast test bars were cast in chill moulds and machined to size. The moulds, however, were heated to a fairly high temperature prior to casting, with the result that the chilling effect on the alloys was not very intense.

The main conclusion to be drawn from the various tests is the great superiority as regards mechanical properties possessed by the alloys that have been worked—whether hot-worked by forging or extruding, or also cold-worked by strip rolling.

The mechanical properties of the alloys have no definite theoretical interest. The test results do, however, indicate what can be expected from these alloys by anybody who wishes to incorporate them in any engineering structure. In general, it is the aircraft engineer who might be expected to be interested in such light materials. It is a little doubtful whether for his purpose the alloys really are effectively light, in view of their low elasticity and not conspicuously good mechanical properties.

The slightly heavier alloys of aluminium are much better in both respects. Better properties in the magnesium alloys may follow from their further development.

Mr. S. L. Archbutt said that the results announced by the author were very welcome to himself and his colleagues at the National Physical Laboratory, who during the war period had done work on similar lines in connection with the rich aluminium alloys. It was hoped that the results could be reported to the Institute at that meeting, but it was found necessary to postpone their presentation. They were somewhat disappointing, but Dr. Aitchison's results were in general agreement with the figures which were then worked out. The most promising alloy appeared to be the 6 per cent. aluminium alloy. In the form of rolled sheet it gave a specific tenacity of 300 compared with 270 for duralumin, and 360, which was the highest value obtained for a light alloy. The advantage of lightness was, however, largely discounted by the disappointingly low elastic modulus, to which attention had been directed by Dr. Aitchison. The value obtained at the National Physical Laboratory was even lower, but for aluminium alloys the figure was 50 per cent. higher. Very little was known of the fatigue and resistance properties at high temperatures or the thermal conductivity of these alloys. No tests had been made at the Laboratory. Material containing over 90 per cent. magnesium had been employed for the pistons of internal combustion engines in America with a certain measure of success, and he would like to ask the author if he could give any information as to possible uses of the material for engineering requirements.

Mr. H. T. Maybrey dealt with one or two practical aspects of the subject. It was necessary, he said, to take special precautions to prevent rapid oxidation and consequent firing of magnesium during melting. He had used for this purpose a chloride flux when his company had been called upon to produce magnesium alloy castings. It was, however, very difficult to get a casting which was entirely free from inclusions of the flux except under laboratory conditions. With regard to mechanical properties, the 1 per cent. cadmium alloy gave a yield point of 4.2 tons, an ultimate stress of 12.5 tons, and an elongation of 14 per cent. The 6 per cent. aluminium alloy gave yield point 5.8 tons, ultimate stress 11.25 tons, and elongation 7 per cent. These were more promising figures than those recorded in the paper. Owing to the difference between laboratory and foundry results, his company abandoned the old method of melting. In the search for a flux which could be used without causing inclusions, recourse was had to the metals of the alkaline earths, and much better results were obtained. Experiments were afterwards made to determine the lowest quantity of this dope which would give the best casting, and it was found that 0.1 per cent. of the dope was sufficient. It was metal cast on this method which had been supplied to Dr. Aitchison for his experiments. There was no doubt, however, that the addition of even a very small percentage of the metals of the alkaline earths tended to set up weakness and brittleness, and a recurrence to the old method of melting was made with, he was glad to say, much better results than in the first instance. The great advantage was that the physical properties of alloys prepared in this way were unimpaired.

Dr. W. H. Hatfield thought that a paper of this kind dealing with the properties of alloys should contain analyses. Unless the compositions of the alloys were set out in detail it was not possible to make comparisons with other materials. He hoped the omission would be rectified.

Colonel N. T. Belaiew thought that the most important point was the elastic limit of these alloys. Referring to the 6 per cent. aluminium specimen, he noted that the elastic limit of the first rolled specimen was 5.6, whereas the next had a figure of 8.2. If the second and not the first value was characteristic of this alloy it appeared rather promising for purposes of construction.

Dr. Aitchison said that he would be pleased to give detailed analyses of the materials, which had not been prepared when the paper was written. The points which had been raised by Mr. Archbutt and Mr. Maybrey might easily form the subject matter of another contribution to the Institute. The query raised by Colonel Belaiew opened up an interesting question. He thought the higher figure could be obtained when the most satisfactory heat treatment for the alloys had been worked out. A question had been asked as to the practical application of these metals. A good deal had been done on the Continent in using them for the pistons of internal combustion engines, and the attention of British engineers had been directed to magnesium alloys by the fact that the piston competition in connection with aircraft engines held by the German Government in 1921 was won by a piston for which a magnesium alloy was used. He understood that the result had not, however, been very satisfactory. The alloys were also being used in the construction of pianos and typewriters, replacing wood and steel, but had not been used in engineering construction work owing mainly to their low ductility. It was hoped that means might be found of improving the mechanical properties of this interesting group of alloys.

Professor H. C. H. Carpenter presented a paper, of which he and Mr. C. Coldron Smith are the joint authors, on "Tests on Work-hardened Aluminium Sheet," from which we abstract the following passages :—

WORK-HARDENED ALUMINIUM SHEET.

Long-period heating tests on the rate of softening of work-hardened aluminium sheet have been carried out in the temperature range 200 deg. to 100 deg. Cent. The total period of the test was 41,000 hours (4.68 years). Mechanical tests were carried out on the sheet from time to time. After 2.46 years the specimens were cooled to the ordinary temperature and maintained there for two months, and then reheated to the original temperatures. The heating was continued for a further period of 2.22 years. After the first period (2.46 years) the percentage loss of work-hardness was as follows :—

Temperature, deg. Cent.	Percentage loss of work-hardness (tenacity).
200	66
175	51
150	42
125	36
100	23

After the resumption of the tests following on the two months' interval at the ordinary temperature the specimens gained in tenacity, and after the total period of 3.65 years the percentage loss of work-hardness was as follows :—

Temperature, deg. Cent.	Percentage loss of work-hardness (tenacity).
200	57
175	40
150	30
125	24
100	11

After 4.68 years the percentage loss of work-hardness in the specimens heated at 200 deg. Cent. was the same as after 2.17 years, whereas in the specimens heated at 150 deg., 125 deg., and 100 deg. it was less. Structural changes in the sheet are very slight even after 4.68 years at the temperatures in question. There are slight evidences of surface recrystallisation, of the development of a granular structure, and the blurring of the original boundaries of the flattened crystals. Nothing like a general recrystallisation takes place, such as is observed at temperatures from 250 deg. Cent. upwards. Tests carried out for 4.14 years at 75 deg. and 50 deg. Cent. show that the retention of work-hardness was practically complete. Slight fluctuations in tenacity occur; but, viewed from a practical standpoint, no loss of work-hardness occurs. Tests at air temperatures extending over a period of five years show that no work-hardness is lost over this period. The influence of thickness was tested for sheets of three different thicknesses at three different temperatures. Viewing the results as a whole, the differences in the rate of loss of work-hardness were not large, but they tended to be larger the greater the amount of work done on the sheet. The influence of composition has been tested for sheets of three different qualities at three different temperatures. At 125 deg. Cent. sheet of 99.65 per cent. purity retained its work-hardness more than twice as well as sheet of 98.9 per cent. purity over a period of 5000 hours. Elastic limit determinations of the sheets, kindly carried out by Dr. Stanton for the authors, gave values of about 3.5 tons per square inch for the work-hardened sheet, and about 1.1 to 1.2 ton for the completely softened sheet. No yield point was detected in any of the tests of the annealed sheets, and it was discovered faintly in only one of the tests of the hardened sheet. Values of the modulus of elasticity are also given.

Dr. D. Hanson said that the paper was mainly a record of experimental results stated with such lucidity as to leave no room for criticism. He had been engaged in a somewhat similar investigation, and he agreed that the amount of experimental data available was insufficient to enable a definite expression of opinion to be made as to the cause of the remarkable changes which had been observed, particularly at the lower ranges of temperature. In the case of tests carried out at higher temperatures than 200 deg., it was possible to reach a conclusion on some points, particularly the influence of composition. The aluminium constituent was not, he would point out, pure aluminium, but contained silicon, which was dissolved in it, and the quantity was more than sufficient to form the constituent *x*. The variations in commercial aluminium could, he thought, be attributed to the silicon and not the iron content.

Mr. W. B. Clarke referred to the impurities present in aluminium. He had been using a material of 99.9 per cent. purity, but he admitted the difficulty of obtaining on a commercial scale metal of that high quality. He would like to know whether in preparing the samples of the work of the authors they were melted in an ordinary crucible furnace to which air had access, or whether special precautions were adopted to prevent the access of air during melting operations. It would be found, he believed, that a great deal of the trouble which had been experienced was due, not to the influence of oxygen, but of the sulphur present in the coke and the gas. The silicon and iron came out of the crucible. A graphite crucible gave good results in eliminating the iron and silicon content except that present in the original metal. Care must be taken, of course, in the use of a flux. Sulphur was a bugbear in many cases, but particularly in the case of nickel. He would like the authors to tell him whether the sheets were prepared in a non-oxidising atmosphere or in a closed muffle. He wanted to make it clear that if proper care were taken metal of a very high degree of purity could be produced, and could be drawn down to the finest gauges.

Mr. Coldron Smith replied to the discussion. Dr. Hanson had, he said, made an interesting suggestion, but he did not think he had given a complete explanation of the softening which took place at the higher temperatures. Where re-crystallisation took place the size of the crystal varied consistently with the purity of the metal. That pointed to the lowest maximum stress being obtained with the purest metal, which was actually the case. Dealing with Mr. Clarke's questions, the aluminium which was supplied by the British Aluminium Company was of 99.6 per cent. purity. The specimens were heated in a closed oven, and he did not think they could have suffered any ill-effects from gas.

A discussion followed on the paper by Dr. J. L. Houghton and Miss K. Bingham, "The Constitution of Some Alloys of Aluminium with Copper and Nickel."

Dr. D. Hanson congratulated the authors on the successful termination of a very difficult research. Nobody could fail to be impressed with the great complexity of the alloys investigated. Only a few of the ternary alloys had been studied, but all those which had been investigated were found to be much more complex than the binary alloys, and the amount of work required was really prodigious. The research had been confined to an examination of the alloys which had, or appeared to have, industrial applications, but from the scientific point of view it was necessary to examine the whole system. What had been done was, however, of great interest, and showed the remarkable mechanical properties which could be obtained by selected heat treatment, although the authors had failed to emphasise that aspect of the research.

Professor Carpenter laid stress on what had been said as to the complexity of the work. He agreed that although the investigations had been limited to certain alloys the whole range must be brought under review.

Dr. Houghton, in summing up the discussion, said that he and his fellow-author felt some diffidence in drawing conclusions from the heat-treatment experiments, as they had not done any work with alloys containing magnesium. Segregation was the main cause of trouble with these alloys, but it was not quite clear what took place. They had investigated about sixty different alloys in the course of the research.

In the absence of the author, Mr. Maurice Cook, his paper, "The Re-crystallisation of Cold-worked Cadmium," was taken as read.

Dr. Hanson had a serious criticism to make. The results obtained by the author could be explained in a much simpler manner than that put forward in the paper. Mr. Jenkins and himself had been engaged in study of cadmium during the past few months, and a had obtained unmistakable evidence of an allotropic change. Beta cadmium did not exist in a stable form at 60 deg. Alpha cadmium was formed. The structure shown in Mr. Cook's photograph was the structure of alpha cadmium. The results disclosed in the paper were capable of explanation on the allotropic theory.

Professor Carpenter said the evidence of the allotropic change was of three kinds : a change in specific gravity, a change in the Brinell hardness number, and re-crystallisation effects. It was very unwise to ignore this evidence, which all pointed in the same direction. The allotropic change must be taken into account.

Professor Thomas Turner then presented the paper by Dr. Arthur W. Gray, "Volume Changes accompanying Solution, Chemical Combination, and Crystallisation in Amalgams." This concluded the morning session.

The annual dinner was held at the Trocadero Restaurant in the evening. Mr. Leonard Sumner (President) was in the chair, and a distinguished company included Sir John Dewrance (President, Institution of Mechanical Engineers), Engineer-Vice-Admiral Sir George Goodwin (President, Institute of Marine Engineers), Mr. Edwin H. Lewis (President, West of Scotland Iron and Steel Institute), Sir Frank Heath (secretary, Department of Scientific and Industrial Research), Colonel C. T. Heycock (Prime Warden of the Goldsmiths' Company), Colonel R. A. Johnson (Royal Mint), Sir Joseph Petavel (Director, National Physical Laboratory), Mr. A. Chaston Chapman (President, Institute of Chemistry), Mr. C. C. Paterson (Vice-president, Institution of Electrical Engineers), Air-Vice-Marshal Sir Geoffrey Salmond (Director-General of Supply and Research, Air Ministry), and Sir Gerard Muntz.

The toast of "The Institute" was proposed by Sir Thomas Holland (Rector of the Imperial College of Science and Technology), and suitably acknowledged by the President, who commented on the work of the Institute in bringing together the scientific worker, the user of metals, and the manufacturer.

BOOKS RECEIVED.

The Manufacture of Lubricants, Shoe Polishes, and Leather Dressings. By R. Brunner. Third edition, revised and enlarged by H. B. Stocks. London : Scott, Greenwood and Son, 8, Broadway, Ludgate, E.C. 4. Price 10s. 6d. net.

The Transactions of the Institution of Naval Architects, 1922. Vol. LXIV. Edited by R. W. Dana, O.B.E., M.A., M. Inst. C.E. London : The Institution of Naval Architects, 5, Adelphi-terrace, W.C. 2, and Henry Sotheran and Co., 43, Piccadilly, W. 1.

Probleme der Weltwirtschaft. Schriften des Instituts für Weltwirtschaft und Seeverkehr an der Universität Kiel Herausgegeben von. Prof. Dr. Bernhard Harms 38. Vereinheitlichung Industrieller Produktion von Dr. sc. pol. Hans Lage. Jena : Verlag von Gustav Fischer. Price not given.

Department of Scientific and Industrial Research. Fuel Research Board. Technical Paper No. 5. : An Apparatus for the Measurement of Specific Gravity of Gases in Small Quantities. By A. Blackie, M.A. London : His Majesty's Stationery Office, Imperial House, Kingsway, W.C.2. Price 3d. net.

The Wickman Gauge Measuring Machine.

IN setting out to design the universal gauge-measuring machine illustrated herewith, Mr. Axel C. Wickman, of Alfred Herbert, Limited, Coventry, had in his mind the paramount necessity in every sound system of workshop gauging for some wholly trustworthy means whereby the gauges in everyday use might be checked for accuracy against some accepted standard. It is generally appreciated nowadays that in order to produce work to prescribed limits of accuracy the workshop gauges used must be made to finer limits than those set for the work, and that the standards of reference behind the workshop gauges must be still more accurate. Granted the existence of these requirements, it is obvious that the whole system may still prove of illusory value if the accuracy of the means employed for comparing the workshop gauges and the standards of reference is widely different from the accuracy of the standards themselves.

Hitherto, except in the case of certain large establishments provided with scientifically equipped laboratories, the examination of workshop gauges has been confined to periodic comparison of them with a series of check gauges which themselves have from time to time to be submitted to the examination of some outside body, such as the National Physical Laboratory, possessing the necessary means for verifying them. Mr. Wickman's objective was to devise a machine which at a reasonable cost might be installed by any firm in its tool room, and which would enable the verification of workshop gauges to be carried out quickly, as a matter of routine, with the full degree of accuracy required, and withal without necessitating the provision of laboratory conditions, such as an extremely rigid foundation, an equable temperature, absence of vibration, and operation by a highly trained and expensive observer. The task which Mr. Wickman thus set himself to fulfil may seem to some over-ambitious, but having inspected his completed machine and handled it when simply placed on the floor, without bolting thereto, of an overhead gallery of the Coventry works, the vibration of which was clearly perceptible by the unaided senses, we have to record our opinion that in no essential respect has he failed to achieve his object.

A general view of the machine is given in Fig. 1, but in order to make its construction and action clear, we have prepared a diagram of its primary parts given in Fig. 6. On a strong pedestal casting A a very stoutly constructed bed B rests on a three-point support providing means for accurately levelling the bed. On top of the bed there is a longitudinal slide C which itself carries a cross slide D provided with adjustable centres E for the reception of plug gauges. A lug on the longitudinal slide is provided to receive a spindle F, the free end of which is formed as an anvil face. In line with this spindle is the spindle G of the measuring head H. This head is fixed adjustably to the bed B, the spindle G being moved by means of a micrometer screw operated from the graduated wheel J with which a vernier is associated. Between the measuring head and the longitudinal slide is a carriage K capable of sliding lengthwise and provided with centres for supporting a plug gauge when it is desired to measure it between the anvil faces of the spindles F G. The carriage K may be removed and in its place there may be put a floating table to support one or more slip or block gauges in order that the anvil faces may be separated by a known distance. The slide C is constantly pulled over towards the right by means of an attached weight working in a dashpot. Ordinarily the limit to its rightwards movement is set by the contact of the anvil faces of the spindles F G or by contact of these faces with a gauge or other body placed between them. The action of the dashpot in which the balance weight works is such that while the contact is firm it is never violent enough either to damage the anvil faces or to deform an interposed body. For some purposes it is necessary to restrict the rightwards movement of the carriage C while leaving its leftwards movement free. To this end a stop L may be fixed in a lug attached to the bed B so as to co-act with another stop fixed in a lug on the carriage C. Attached to the bed B behind the carriage and cross slide is a casing containing the indicating gear. The stylus M of this gear lies in the horizontal plane of the centres E. Its movements to the right or left in that plane are magnified four-thousandfold by a mechanical-optical system—described below—and are shown on a ground glass screen N on the front of the casing. The method of mounting the stylus is such that it may be moved axially at right angles to the centres E without causing sensible movement of the image on the glass screen.

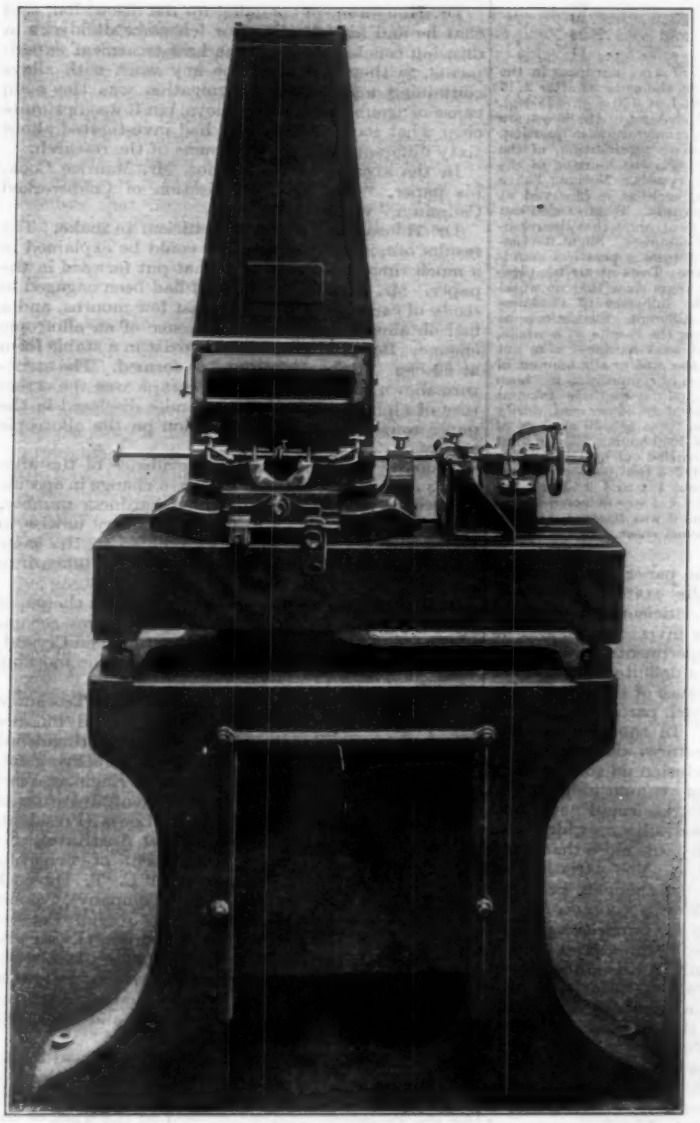
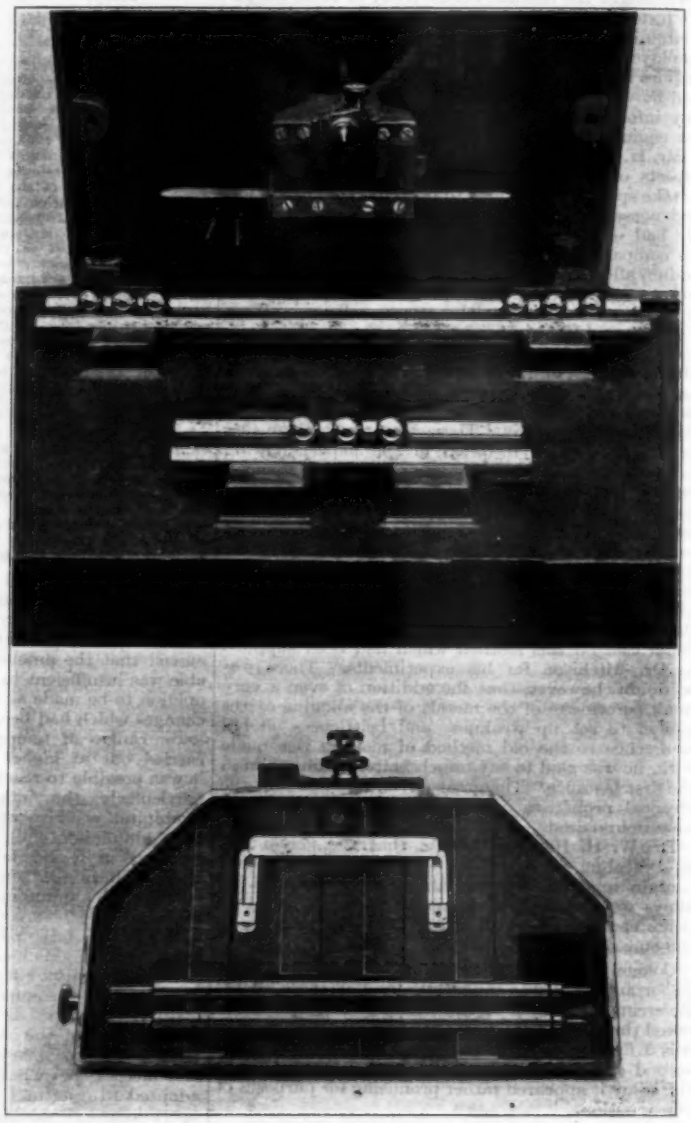


FIG. 1—FRONT VIEW OF WICKMAN MEASURING MACHINE



FIGS. 2 AND 3—METHOD OF SUPPORTING MAIN SLIDE

The machine is capable of effecting all classes of measurement on plain or screwed plug or ring gauges, including effective diameters of both external and internal screw gauges. To describe how it is handled and the accessories required for all the possible styles of measurement would leave us no space to deal with certain of its constructional features, which in our view are of more and wider interest than a detailed account of the method of operating the machine. We will therefore confine ourselves to a statement of the course followed in (1) the measurement of the diameter of a plain plug gauge, and (2) the measurement of the pitch errors in a screw plug gauge.

In the first-named instance a dummy gauge of the form shown at P in Fig. 6—a fitting forming part of the equipment and comprising a collared shaft with a plain V groove on the edge of the collar—is inserted between the centres E. The slide D is then advanced and the carriage C moved longitudinally by means of the wheel J or otherwise until the stylus engages with the groove of the dummy P. The exact position of the image on the screen, a band about ¼in. wide, is not important so long as it is visible towards the *left* of the two central dividing marks. With the image so situated the stops L are adjusted to hold the carriage C against the rightwards pull of the balance weight, and thus permit the anvil faces of the spindles F G to be separated by means of the wheel J until the gap between them is something in excess of the diameter of the gauge to be examined. If that diameter is, nominally, 1in., a 1in. gauge block is inserted between the anvil faces and the wheel J turned so as to close these faces on the block. When contact is established, farther rotation of the wheel J will move the carriage C to the left and result in the image on the screen moving towards the right. The reading on the wheel J and its vernier is taken when the image on the screen has been moved so as to come between the central dividing lines marked thereon. This reading should be repeated when the gauge is substituted for the block, and the image on the screen is again centralised. If it is not repeated the discrepancy as read from the graduated wheel and vernier is a direct measure of the magnitude of the error in the gauge. No great precision is required in fitting the image on the screen into the space between the two central marks, an accuracy of $^1/_{32}$in. in this respect being sufficient to secure an accuracy of one-hundred-thousandth of an inch at the measuring head.

To examine a screw plug gauge for pitch error the gauge is mounted between the centres E, the stops L are thrown out of action, and the anvil faces of the spindles F G are caused to abut against each other. By the longitudinal adjustment of the slide C and the cross adjustment of the slide D, the first trough of the thread is caused to engage with the stylus, and the image on the screen is brought between the central division marks. The reading of the wheel J and its vernier is then taken. The micrometer screw has a pitch of $^1/_{40}$in., and for simplicity it will be assumed that the gauge has also a nominal pitch of this amount. One turn of the wheel J should therefore move the carriage C and with it the gauge under examination over towards the left by $^1/_{40}$in. During the first portion of this movement the image is carried right off the screen as a result of the horizontal leftwards displacement of the stylus. But as the movement proceeds the point of the stylus moves axially backwards in addition to horizontally in an arc, such a movement being accommodated, as we have already stated, by the means provided for the support of the stylus. The recession continues with the leftwards movement of the gauge until the stylus mounts to the crest of the thread. The stylus point then slips forward into the succeeding trough and the image on the screen,

returning to the central position, overshoots it on the opposite side. The displacement of the gauge leftwards is continued until the image again returns to the central position. When this condition is reached the reading of the wheel J and its vernier is again noted. With a gauge having forty threads per inch it ought to be the same as the first reading. If it is not, the discrepancy is a direct measurement of the pitch error. The actual handling of the machine for the purpose of this examination is quite simple and very rapid, all the pitches of a gauge of ordinary length being readily examined within five minutes or so.

As illustrating the accuracy with which the machine will repeat its indications and its freedom from the influence of the operator's personality, we give below two sets of readings made on the one gauge, the first set having been obtained with Mr. Wickman operating the graduated wheel and fitting the image into the central position, while our representative took the readings of the wheel and vernier, and the second set with our representative as operator and Mr. Wickman as reader. The figures clearly support the claim that the machine gives readings to an accuracy of one-hundred-thousandth part of an inch.

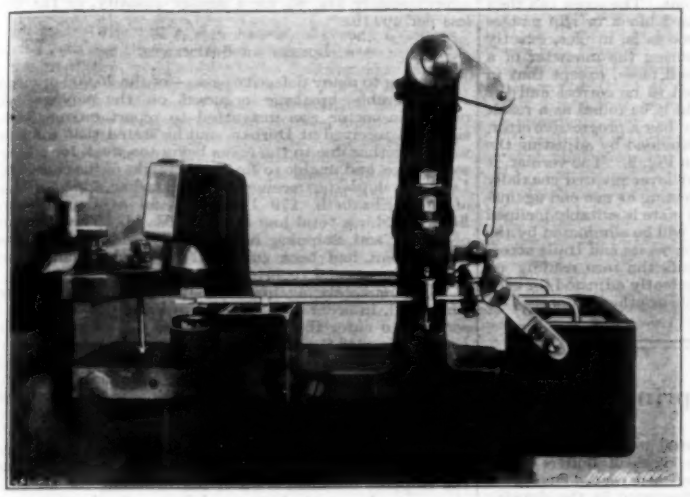
Gauge 1*in. diameter B.S.F. ten threads per inch nominal.*

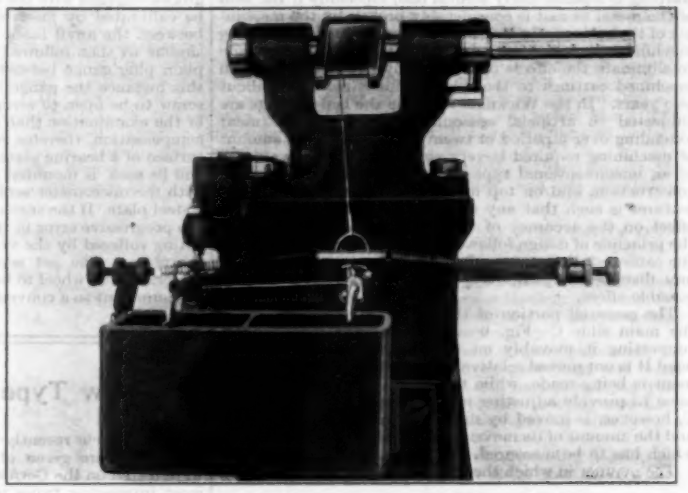
Reader		A		B
Operator		B		A
1st pitch	.. $^1/_{10}$in.	−.00002	.. $^1/_{10}$in.	−.00003
2nd ,,	..	−.00001	..	−.00001
3rd ,,	..	−.00000	..	−.00000
4th ,,	..	−.00000	..	+.00001
5th ,,	..	+.00004	..	+.00004
6th ,,	..	+.00007	..	+.00007
7th ,,	..	+.00000	..	+.00008
Aggregate error	..	+.00017	..	+.00016

As we have already mentioned, many interesting constructional features are embodied in the design of the machine. The indicating mechanism whereby the movement of the stylus is multiplied four-thousandfold on the screen is especially worthy of close examination. Side and rear views of this mechanism are given in Figs. 4 and 5—for a front view of the stylus and its support see Fig. 2—but in order to make the design understood we have again found it necessary to prepare a diagrammatic sketch—Fig. 7.

The stylus A is fixed in a head B supported from the bed C of the machine by means of two thin strips of spring steel D, and a double-pointed needle strut E. This form of support is not claimed by Mr. Wickman to be original, but is taken, we believe, from the practice of the National Physical Laboratory. It is such as to hold the stylus rigidly, yet entirely without friction, against pure sideways movement, while permitting it to move axially in and out under the elastic control of the spring strips. In addition, it allows the stylus to move through a horizontal arc, this movement being accommodated by the flexure of one spring strip outwards and the other inwards. The axis about which this arcual movement takes place is, we believe, a vertical line in the plane of the spring strips and midway between them. Its exact position affects the magnification ratio, but since all readings are taken with the stylus occupying the one self-same central position, variation of the axis, if it exists, is without effect on the accuracy of the measurements. Moreover, since the stylus is always brought into the central position in one direction and not from either side indiscriminately, any hysterisis in the springs would likewise have no influence on the readings. In the latest design of the machine the two spring strips D are replaced by a single strip of the same effective width, the object being to secure increased resistance to lateral movement. The arcual movement is not affected by this modification.

From the head B a rod F extends rearwards, and ends in a plate dipping into an oil dashpot. It is connected to a second rod G, pivoted at H, by means of a needle strut J and two tension springs K. This second rod carries a frame L across which is stretched a thread—actually a portion of the filament of an incandescent lamp. It is further equipped with a dashpot plate similar to that on the first rod and with an additional plate dipping into a supplementary dashpot M. It has been found that this supplementary dashpot is unnecessary, and that the two pots N are sufficient to secure the dead beat movement of the image on the screen. It has also been discovered that if the two pots N are filled with oil to the same depth vibrations originating outside the machine will cause the image to dance on the screen. If, however, the level of oil in one pot is made about half as high as that in the other, the natural periods of oscillation of the two columns of liquid effectively damp each other, with the result, as we can confirm from our own observations, that considerable external vibration may be present without causing visible tremor of the image.





FIGS. 4 AND 5—SIDE AND REAR VIEWS OF MECHANICAL PORTION OF MULTIPLYING GEAR

The mechanical details between the stylus and the frame L result in the movement of the stylus being multiplied about sixty-fold. Thereafter the movement is farther multiplied about seventy times—bringing the total ratio up to 4000 to 1—by means of an optical system consisting of a "Pointolite" lamp, a lens P, two mirrors Q R, and the screen S. The image of the filament in the frame L is thus cast upon the screen and forms a band about $\frac{1}{16}$in. wide, which, in operating the machine, is fitted into the space between the two central lines marked permanently on the screen. In the diagram the lens P is shown, simply for convenience of drawing, with its axis inclined. Such an arrangement in practice would result in one end of the image of the filament being thrown out of focus. The lens is therefore set vertically.

Geometrically considered, axial movement of the stylus A is not without effect on the frame L. Actually, however, the proportions of the parts are such—and in particular the length of the needle J, which is about 3in.—that any axial movement of the stylus is reduced and not multiplied at the frame L. The movement of the frame, and therefore of the image on the screen, it may be taken practically, is affected only by the angular swing of the stylus point about the imaginary vertical axis in the plane of the spring strips.

The return of the stylus to the central position is dependent upon the elasticity of the strips D. For some purposes, for example, in the measurement of internal

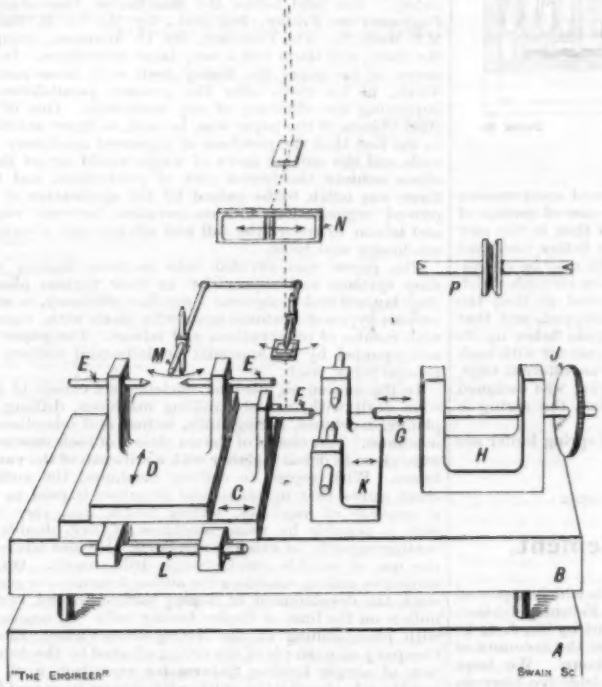


FIG. 6—DIAGRAM OF MEASURING MACHINE

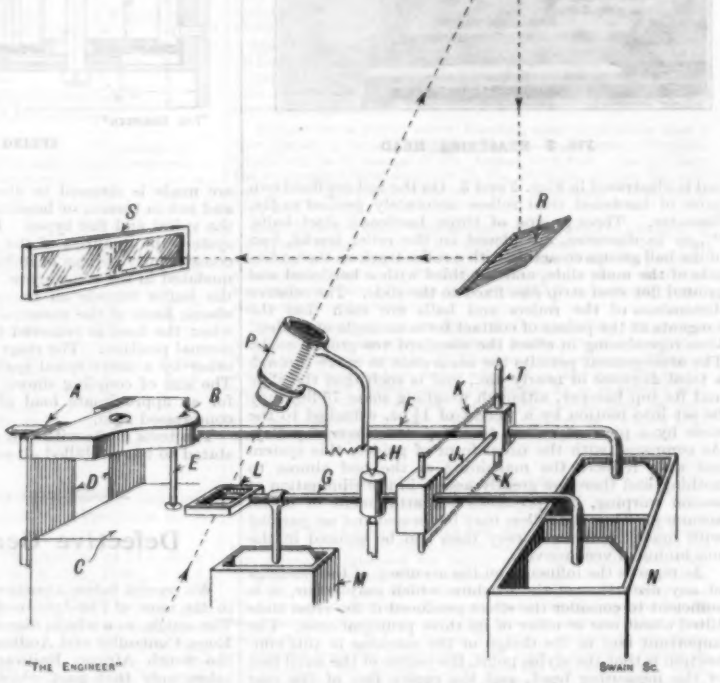


FIG. 7—DIAGRAM OF MULTIPLYING GEAR

diameters, the force thus supplied is insufficient and has to be reinforced by means of the details shown in Fig. 5—namely, a central plate which is attached by springs to two fixed abutments, and which may be lowered on to a vertical pin extending upwards from the first multiplying lever—see T, Fig. 7.

In the construction of all forms of scientific measuring machines accuracy in the sliding surfaces is probably the most difficult requirement to secure. It is not only that such surfaces are difficult to prepare with the desired accuracy; it is difficult to preserve them in their original state of accuracy partly because of wear and partly because of the warping of the metal—usually cast iron—of which they are made or upon which they rest. The question of warping is a particularly serious one, especially if the skin of the metal as cast is considerably broken by the machining of the surface. In the case of a foreign-made measuring machine with which we are acquainted, efforts are made to eliminate the effects of warping by exposing the rough machined castings to the weather for a period of about two years. In the Wickman machine the bed castings are subjected to artificial seasoning by a heat treatment extending over a period of twenty-four hours, the amount of machining required is very small, the sliding ways are of an unconventional type, permitting great accuracy of construction, and on top of all, the design of the salient features is such that any distortion produces little or no effect on the accuracy of the readings. In other words, the principle of design followed is to take all steps to reduce the causes of distortion and simultaneously to ensure that any distortion which may occur will exercise the least possible effect.

The essential portion of the machine in this respect is the main slide C—Fig. 6—and the means provided for supporting it movably on the bed B. The measuring head H is not moved relatively to the bed when a measurement is being made, while the slide D and the carrier K have to provide adjusting motions only. The main slide C, however, is moved by means of the micrometer screw and the amount of its movement is in all cases the quantity which has to be measured.

The manner in which the main slide is supported on the

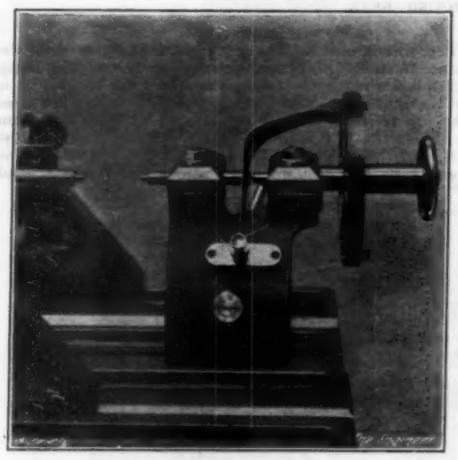


FIG. 5—MEASURING HEAD

bed is illustrated in Figs. 2 and 3. On the bed are fixed two pairs of hardened steel rollers accurately ground to ¾in. diameter. Three groups of three hardened steel balls, $^{11}/_{16}$in. in diameter, are placed on the roller tracks, two of the ball groups co-acting with a roller track on the underside of the main slide, and the third with a hardened and ground flat steel strip also fixed to the slide. The relative dimensions of the rollers and balls are such that the tangents at the points of contact form an angle of 60 deg., thus reproducing in effect the standard vee groove angle. The arrangement permits the main slide to move through a total distance of nearly 4in., and is such that the slide and its top hamper, although weighing some 75 lb., may be set into motion by a weight of 1¼ oz. attached to the slide by a piece of cotton thread passing over a pulley. As compared with the usual form of guides, this system not only reduces the machining of the bed almost to nothing, and therefore greatly assists in the elimination of season warping, but promotes the attainment of initial accuracy. Thus the rollers may be formed and set parallel with much greater accuracy than can be secured in the machining of vee grooves.

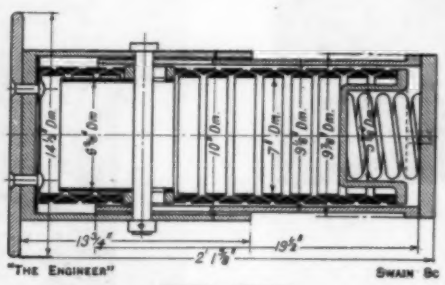
As regards the influence on the accuracy of the readings of any distortion of the machine which may occur, it is sufficient to consider the effect produced if the cross slide tilted about one or other of its three principal axes. The important fact in the design of the machine in this connection is that the stylus point, the centre of the anvil face of the measuring head, and the centre line of the rear guiding track on the bed all lie in the same plane. It is claimed as a consequence of this feature that if the cross slide should twist about an axis perpendicular to its base the length of the displacement couple at the stylus point will be identical with that at the measuring end, and that consequently no error in measurement will occur, a similar remark applying to the tilting of the cross slide about an axis parallel with its base and at right angles to the guiding track. We have to admit that we have found some difficulty in following the argument here employed. Even though we accept it as correct, it seems to take into consideration twisting of the sliding carriages alone and to ignore the equal possibility of twisting of the main bed. In the latter connection, however, it would appear that any twist likely to develop would have but slight effect on the accuracy of the measurements made on the machine. Thus in the case of a screw plug gauge having ten threads per inch the guiding track would need to twist through an angle of 49 min. from its true position before the error introduced in the pitch measurement exceeded 0.00001in. As regards the tilting of the cross slide about an axis parallel with the guiding track, the effect would be to move the stylus axially, and, as already stated, such movement is substantially without effect on the position of the image on the screen.

One other important feature of the machine may be mentioned by way of conclusion. It is obvious that its accuracy depends in marked degree upon the accuracy of the micrometer screw. As the screw has a total travel of about 1¼in., and as it is open to develop material error by wear it is highly important that it should be possible to check it without much trouble against some standard. The construction of the machine permits this operation to be quickly carried out without entailing the removal of the screw from its housing. To this end the dummy piece P—Fig. 6—is inserted between the centres E, and its groove engaged with the stylus point. The screw can then be calibrated by inserting standard block or slip gauges between the anvil faces. The process is, in fact, exactly similar to that followed in measuring the diameter of a plain plug gauge between the anvil faces, except that in this instance the gauge is assumed to be correct and the screw to be open to error. Should it be found as a result of the examination that the screw has a progressive error, compensation therefor may be provided by adjusting the surface of a bearing plate shown in Fig. 8. The vernier, it will be seen, is mounted on a bent lever pivoted coaxially with the micrometer screw, and resting at one end against a steel plate. If the surface of this plate is suitably inclined the progressive error in the screw will be eliminated by the tilting suffered by the vernier lever as its end trails across the plate. The set screw permits the zero reading on the graduated wheel to be independently adjusted for each measurement to a convenient whole or other figure.

A New Type of Spring Buffer.

In an article recently contributed to the *V.D.I.*, some particulars are given of various types of buffers which were tested on the German railways last year. One of the most interesting types is that illustrated in the drawing we reproduce below. The essential working parts compriso a series of springs in the form of solid rings which fit into each other, and are formed with wedge-shaped edges. These rings, termed Kreissig rings, are of patented construction. The arrangement of the ring system is such that when compressed by impact, work is taken up by the friction of the ring faces, and the work absorbed by the system is many times larger than that given up again when the pressure is released.

It will be noted that the material from which the rings



SPRING BUFFER

are made is stressed in direct tension and compression, and not in torsion or bending, as in the case of springs of the spiral and flat types. It is claimed that in the new system the qualities of the material are better used and consequently springs of increased strength may be accommodated in the same space. The distance through which the buffer travels on impact is calculated so that the elastic limit of the material is not overstepped, and that when the load is removed the spring again takes up its normal position. The rings are held in contact with each other by a short spiral spring fitted in an internal cage. The size of coupling shown in the drawing was designed for an approximate load of 28 tons when the spring is compressed 2¾in.

The tests made with this new type of spring buffer are stated to have fulfilled all expectations.

Defective German Cement.

We reprint below a portion of an article which appeared in the issue of *The Johanneburg Star* for February 1st last. The article, as a whole, discusses the report by Mr. J. de V. Roos, Controller and Auditor-General, on the accounts of the South African Railways and Harbours. We have taken only that part which refers to defective German cement and the method of packing it for carriage to South Africa:—

Defective German Cement.

"To meet the urgent requirements of the Administration, the High Commissioner in July, 1920, placed orders for 25,000 casks of cement with German firms, and delivery in South Africa was made in the following year. Included therein were 5000 casks of a brand 'F,' which, on being tested in South Africa, was found to be so far below the strength shown on the specification submitted by the High Commissioner, that the chief civil engineer debarred its use in any work subject to shocks or strains, and instructed that any engineer to whom it was supplied should be made aware of its character. The general manager informed me that the quality of the 'F' cement was reported to the High Commissioner, who replied that his inspector "carried out tests as to tensile strength, and furnished a test certificate.' The general manager also informed me that similar tests made at East London showed that this cement was of a lower standard, although, on the other hand, the Government analyst reported that the cement complied with the British standard specification as regards chemical analysis. The general manager added: 'On arrival in the country, our highest technical officers condemned it for use on certain works, but did not wholly condemn it for general use, so that the purchase is not a loss in actual fact.' This cement was indented for to be used principally for harbour construction, but the chief civil engineer has not allowed its use on marine work, and has given instructions that it may be used only 'for concrete foundations for houses, for cement plaster, and generally on maintenance work, except for bridges and reinforced concrete foundations.' The cost of this imported cement was 26s. 1d. per cask of 400 lb. South African cement—including haulage to Durban—costs approximately 14s. 9d. for a similar quantity, or 11s. 4d. less per 400 lb.

Losses on Shipments.

"Owing to many defective casks—of the 25,000 ordered—considerable breakage occurred on the voyage. A marine inspector was instructed to report on one consignment received at Durban, and he stated that the loss was altogether due to the casks being too weak for a long sea voyage, and unable to stand the weight of the contents. Losses on shipments received were at Durban, £185 4s. 7d.; at Port Elizabeth, £79 17s. 5d.; and at Cape Town, £192 8s. 2d.; a total loss of £457 10s. 2d. The Director of Stores and Shipping in London considered that the consignment had been subjected to rough handling on the Continent, and reported further:

"Unfortunately, against my better judgment, we were compelled, in order to assist you to bring down prices of cement, to enter the German market for supplies under Indent No. 249.G, and although the contract was very favourable as regards prices and delivery when it was made, the suppliers' attitude was most unsatisfactory through the period. Several consignments of casks were rejected before casks which were in any way acceptable were put forward.

"I am satisfied that it was impossible to obtain better casks from these people at the date of shipment, and as the shippers obtained a clean bill of lading for all consignments, I regret to have to advise you to abandon your claim in this instance.'

"The chief railway storekeeper stated in a minute to the general manager: In connection with these shipments generally, whilst some blame may be attached to the overseas inspectors, it should be borne in mind that: (1) That cement was said to have been urgently required; (2) South African cement was unobtainable in sufficient quantities; (3) imported cement was extremely difficult to obtain at the time; (4) only one offer of British cement was received, and that at 30s. f.o.b."

Workshop Efficiency.

An admirable paper dealing with "Workshop Efficiency" was read before the Manchester Association of Engineers on Friday, 2nd inst., by Mr. G. E. Bailey, M.I. Mech. E. The President, Mr. D. Adamson, occupied the chair, and there was a very large attendance. In the course of his paper Mr. Bailey dealt with those matters which, in his view, offer the greatest possibilities for improving the efficiency of our workshops. One of the chief objects of the paper was, he said, to direct attention to the fact that the purchase of improved machinery and tools and the cutting down of wages would not of themselves achieve the lowest cost of production, and that there was much to be gained by the application of improved organisation and co-operation between capital and labour to ensure the full and efficient use of existing machinery and tools.

The paper was divided into sections dealing with shop systems and supervision in their various phases; shop lay-out and equipment; machine efficiency, in which various types of machine tools were dealt with, together with results of observations and labour. The paper was accompanied by an appendix on industrial welfare and general social work.

In the section on machine efficiency six classes of tools were dealt with, namely, milling machines, drilling and planing machines, boring mills, lathes, and miscellaneous machines. Test charts of the six classes of tools mentioned were given in detail together with a criticism of the various losses. With regard to drilling machines, the author's chart shows that unless special attention is paid to ease of controls of machines, setting tables, &c., very little gain is possible by using machines of, say, double the cutting capacity of existing machines. He also advocates the use of reliable quick-change drill chucks. On the subject of milling machines the author forecasts for general work the development of duplex horizontal and vertical millers on the lines of duplex boring mills. In connection with plano-milling at the Metropolitan-Vickers Electric Company an example of the saving effected by the duplication of simple loading fixtures for repetition work was mentioned, whereby the cutting times were increased from 25 to 48 per cent.

Discussing the planing machine, Mr. Bailey said that sufficient attention had not been given by the makers to the improvement of its efficiency. In his works fully 75 per cent. of the planing work was suitable for double-cutting planers. The following figures showing the efficiency of planing machines are taken from a chart given by the author:—

		Per cent.
C.	Cutting metal	21.0
A.	Running on cut stroke, but not cutting	12.0
R.	Return time	15.4
	Total running time	48.4

Taking the running time only as 100 per cent., the following averages can be given:—

		Per cent. of running time.
C.	Cutting metal	43.4
A.	Running on cut stroke but not cutting	24.8
R.	Return stroke	31.8

Railway Results in 1922.

THE seventeen principal railway companies—regarding the Lancashire and Yorkshire as part of the London and North-Western, the Hull and Barnsley as part of the North-Eastern, and the Great Western as including the Alexandra Docks, Barry, Cambrian, Rhymney and Taff Vale—took, during 1922, £227,709,386. Their expenditure was £183,119,998, equivalent to a ratio of 80.44 to the receipts. The net receipts were £44,589,388. As during the first seven and a-half months of 1921 the companies were under Government control, a comparison with 1921 is not practicable, but we make in the accompanying tables comparison with the year 1913.

The year 1913 was a very important year in railway history. It was the first for which figures were returned in the new form prescribed in the Railway Companies' (Accounts and Returns) Act of 1911; it was the last complete year before the seven years' war control, and on its net receipts the compensation to be paid during control was based. Its results have generally been accepted as the basis for the terms for amalgamation and absorption under the Railways Act, 1921. Of perhaps greater present importance is the fact that Section 58 (1) of the Act just named says: "The charges to be fixed in the first instance for each amalgamated company shall be such as will, together with the other sources of revenue, in the opinion of the Rates Tribunal, as far as practicable yield, with efficient and economical management, an annual net revenue (hereinafter referred to as the standard revenue) equal to the aggregate net revenues in the year nineteen hundred and thirteen . . ."

The accompanying Table I. shows the expenditure during 1922 of the seventeen companies. It shows, also, that it amounted to £109,925,129 more than the expenditure of 1913, in which year the ratio of expenditure to receipts was 63.45, as against last year's ratio of 80.44. Despite the higher rates and fares in 1922, as compared with 1913, only nine of the seventeen companies secured higher net receipts. Some, it will be noticed, have now a very much higher ratio than in 1913. The Great Eastern and Scottish companies in particular have been badly hit by the standardisation of wages and the uniform eight hours' day. Lines like the North-Eastern, North Staffordshire and Furness, which depend so much on the iron and steel trade, make, as a result, a poor show. On the contrary, the Southern lines, being less dependent on merchandise and mineral traffic, have done well.

Table II. has been prepared by us to give an idea as to the various items that go to make up a railway company's expenditure. We have chosen the Midland and the Great Northern as two typical companies, as their ratios—expenditure and receipts—were 79.00 and 80.02 respectively as compared with the average of 80.44. This table shows how much more each company paid in 1922 than in 1913. It is instructive that the different items have generally increased in proportion to the total increase.

TABLE I.—*Expenditure of Seventeen British Railways as Now Grouped in 1922 as Compared with 1913.*

	Expenditure in 1922.	Increase in expenditure, 1922 over 1913.	Increase or decrease in net receipts, 1922 over 1913.	Ratio of expenditure to receipts. 1913.	1922.
	£	£	£		
London, Midland and Scottish—					
*London and North-Western	36,517,288	20,390,367	+ 649,596	65.94	79.74
Midland	21,615,447	11,441,410	— 39,313	62.22	79.00
North Staffordshire	1,776,552	1,057,010	— 130,157	63.64	86.52
Furness	839,280	441,849	— 130,252	58.16	86.36
Caledonian	7,384,736	4,091,613	+ 94,090	59.76	77.40
Glasgow and South-Western	3,210,233	1,818,825	— 87,658	61.99	82.13
Highland	910,191	569,270	— 22,135	57.73	79.87
Total for Group	72,253,727	39,810,344	+ 334,171	64.18	79.75
London and North-Eastern—					
†North-Eastern	18,144,052	9,741,463	— 612,156	64.39	83.68
Great Central	9,715,618	5,248,174	+ 77,542	67.73	83.41
Great Eastern	10,970,895	6,305,825	— 412,410	68.36	87.13
Great Northern	10,398,127	5,682,519	+ 296,188	67.24	80.02
North British	8,011,516	4,753,225	+ 123,329	57.64	78.65
Great North of Scotland	761,482	479,713	— 36,384	54.41	80.29
Total for Group	58,001,690	32,210,919	— 563,891	65.51	81.69
‡Great Western	31,102,976	18,500,168	+ 347,235	64.05	81.29
Southern—					
London and South-Western	9,183,932	5,129,355	+ 171,184	64.17	78.26
South-Eastern and Chatham	7,228,431	3,703,076	+ 186,945	62.07	78.07
London, Brighton and South Coast	5,349,242	3,016,250	+ 19,943	61.79	79.17
Total for Group	21,761,605	11,848,681	+ 378,072	64.60	78.92
Total for seventeen companies	183,119,998	109,925,129	+ 242,972	63.45	80.44

* Figures for 1913 include Lancashire and Yorkshire. † Figures for 1913 include Hull and Barnsley. ‡ Figures for 1913 are for Alexandra Dock, Barry, Cambrian, Great Western, Rhymney and Taff Vale.

TABLE II.—*Details of the Increase in Expenditure of Two Typical Companies.*

	Midland.				Great Northern.			
	Increase in 1922 over 1913.	Percentage of increase.	Percentage of traffic receipts. 1913.	1922.	Increase in 1922 over 1913.	Percentage of increase.	Percentage of traffic receipts. 1913.	1922.
	£				£			
Maintenance and renewal—								
Way and works	2,003,502	165.99	8.62	12.67	874,262	133.47	11.05	13.81
Rolling stock	2,277,501	143.33	11.35	15.26	941,064	142.67	11.15	14.47
Locomotive running—								
Wages	1,536,567	174.25	5.83	8.94	658,075	176.00	5.55	7.94
Fuel	852,026	94.66	5.95	6.40	313,443	63.32	7.35	6.15
Other expenses	184,943	130.33	0.94	0.67	154,538	119.79	1.92	2.15
Traffic—								
Salaries and wages	2,662,545	125.12	14.07	17.51	326,724	137.77	14.28	17.54
Other expenses	1,011,502	115.18	5.80	6.88	411,207	102.75	5.91	6.15
General charges	346,868	115.62	2.14	2.55	144,882	100.61	2.44	2.61
Compensation	34,834	—	1.27	0.57	3,004	5.40	0.95	0.54
Rates	368,412	77.40	3.40	3.33	200,778	88.84	3.81	3.86
Other expenditure	980,434	134.69	4.85	6.30	846,074	202.55	6.20	9.69

THE INSTITUTION OF NAVAL ARCHITECTS.

THE Spring Meetings of the Institution of Naval Architects will be held in the Lecture Hall of the Royal United Service Institution, Whitehall, W.C. 2, on Wednesday, March 21st, morning at 11 o'clock, afternoon at 3 o'clock; Thursday, March 22nd, morning at 11 o'clock, afternoon at 3 o'clock, and evening at 8 o'clock; Friday, March 23rd, morning at 11 o'clock, afternoon at 3 o'clock. The annual dinner of the Institution will be held on Wednesday, March 21st, at 7.30 p.m., in the Grand Hall of the Connaught Rooms. The following programme has been arranged:—

Wednesday, March 21st.—Morning meeting at 11 o'clock: (1) Annual report of Council; (2) election of President, officers and Council; (3) presentation of the Institution Gold Medal and Premiums; (4) address by the President, his Grace the Duke of Northumberland, C.B.E., M.V.O. (1) Sir Eustace T. d'Eyncourt, K.C.B., D.Sc., F.R.S., Vice-president, and Mr. J. H. Narbeth, C.B., C.B.E., M.V.O., R.C.N.C., member, "A Proposed Aircraft-carrying Mail Steamer"; (2) Sir John E. Thornycroft, K.B.E., member of Council, and Lieut. Bremner, R.N., "Coastal Motor Boats in War-time." Afternoon meeting at 3 o'clock: (3) Mr. A. C. F. Henderson, associate, "Remarks on Some of the Present-day Problems in the Design of Ships."

Thursday, March 22nd.—Morning meeting at 11 o'clock: (4) The Hon. Sir Charles A. Parsons, K.C.B., D.Sc., F.R.S., Vice-president, Mr. S. S. Cook, member, and Mr. H. M. Duncan, "Mechanical Gearing"; (5) Mr. W. Le Roy Emmet, member of Council of the American Society of Naval Architects and Marine Engineers, "Electric Ship Propulsion." Afternoon meeting at 3 o'clock: (6) Mr. G. S. Baker, O.B.E., member of Council, and Mr. W. C. S. Wigley, M.A., "Model Screw Propeller Experiments with Mercantile Ship Forms." Evening meeting at 8 o'clock: (7) Mr. K. C. Barnaby, B.Sc., member, "The Powering of Motor Ships."

Friday, March 23rd.—Morning meeting at 11 o'clock: (1) Election of new members, associate members, associates and students; (2) appointment of scrutineers for the next annual meeting. (8) Professor T. B. Abell, O.B.E., M. Eng., member of Council, "The Behaviour of Stiffened Thin Plating under Water Pressure"; (9) Mr. J. Montgomerie, D.Sc., member, "Further Experiments on Large-size Riveted Joints"; (10) Mr. John Anderson, member, "The Influence of Form upon the Stability and Propulsion of Passenger Ships." Afternoon meeting at 3 o'clock: (11) Mr. W. Thomson, B.Sc., member, "The Effect of Variations in Loading on Longitudinal Structural Stresses in Ships"; (12) Mr. E. V. Telfer, M.Sc., student, "Graphical Trim Calculation and a Trim Nomogram."

TECHNICAL MEETINGS IN AMERICA.

WE print below a circular letter received from the Association of Iron and Steel Electrical Engineers of Pittsburg. It would seem that in America they advertise technical meetings much as we should a concert or a conjuring entertainment.

DEAR SIR:

"FLEXIBLE COUPLINGS WITH PARTICULAR REFERENCE TO STEEL MILL DRIVES."

Saturday, February 24th, Hotel Chatham,
Dinner 6.30. Meeting 8 p.m. Pittsburg, Pa.

Ever so often you are called upon to prepare a specification for a flexible coupling, and some times you are in doubt as to just what type of coupling to select.

You are familiar, perhaps, with the various makes and types of couplings, still you feel you would like a little more data in connection with the coupling you have in mind.

Your Association realises what a live subject the "Flexible Coupling" has become, and has decided to present for your benefit

"A TOPICAL ENGINEERING DISCUSSION ON FLEXIBLE COUPLINGS."

All the representative manufacturers of couplings have been invited to present a fifteen-minute engineering discussion on their particular coupling and to illustrate their product with lantern slides.

Already six of the largest manufacturers have accepted our invitation to participate in this meeting, and what we now desire is that you steel mill engineers bring your most trying coupling problem to this meeting and have the engineers who will talk that evening offer you a solution.

The Executive Committee of the Pittsburg Section are going to make special efforts to make this meeting not only a technical success but a social one as well.

Dinner 6.30 p.m. Entertainment 6.30. Meeting 8.00 p.m.

EVERYBODY WELCOMED.

BRING YOUR FRIENDS.

Yours very truly,
JOHN F. KELLY, Secretary.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

BARIMAR Limited asks us to state that it has moved to larger and more commodious London premises at 14/18, Lamb's Conduit-street, Theobalds-road, London, W.C. 1.

A. C. ALEXANDRA AND CO., Limited, of 10, Iddesleigh House, Caxton-street, Westminster, London, S.W. 1, inform us that they have appointed Mr. Harold William Sidley general sales manager, and that he will take over the entire control of the sales of their business.

MR. C. F. DENDY MARSHALL asks us to announce that in future all business communications should be addressed to him at 170, Windsor House, Victoria-street, S.W. 1, where he will be available for consultations on matters relating to locomotion and inventions generally.

WAILES DOVE BITUMASTIC, Limited, asks us to state that it has opened a branch office at No. 2, Bank-street, Sheffield, which will be in charge of Mr. Arthur Swindale, who has been the company's representative in the Sheffield district for over two years. Telephone, Central 2086; telegrams, "Bitumastic, Sheffield."

THE CONSOLIDATED PNEUMATIC TOOL COMPANY, Limited, of Egyptian House, 170, Piccadilly, London, W. 1, has been appointed sole selling agent for Weldrics and Weldrines patented electrodes. The works for the manufacture of these electrodes have recently been removed from Scotland to a more convenient site in the London area.

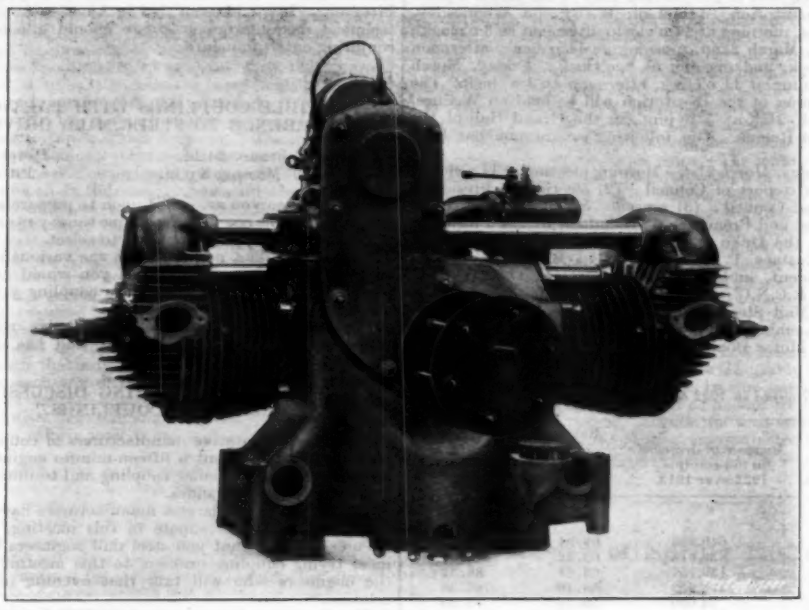
WE are asked to state that Sir W. G. Armstrong, Whitworth and Co.'s hydro-electric department has now been moved from 8, Great George-street, to 51, Victoria-street, where additional accommodation has been taken adjacent to that occupied by the same firm's civil engineering department. It is requested that letters for the hydro-electric department should now be sent to that address. The new telephone number is Victoria 1761 and the telegraphic address is "Ubiquity, Sowest, London."

A NEW OIL CAN.—We have just received from Joseph Kaye and Sons, Limited, of Lock Works, Leeds, a sample of a new oil can primarily intended for motor cycle and similar services. It is an improvement on a somewhat similar can, by the same makers, that we noticed some months ago, and is a very nice piece of manufacturing. The container is formed by two tinned steel circular stampings with the familiar serrated edge associated with the "K" oil cans. The spout is made in one piece of tapered seamless brass tube—not with a soldered nipple as before—while the socket is held into the container by a deep groove cut round the outside and soldered up. The arrangement is such that even after really rough usage there should be very little likelihood of leakage. A small cap with a pricker is screwed on the end of the spout.

THE OPTICAL SOCIETY.—At the annual general meeting, held at the Imperial College of Science and Technology on February 8th, 1923, the following officers and Council were elected to serve for 1923–24:—President, Emeritus Professor Archibald Barr, D.Sc., LL.D., Anniesland, Glasgow; vice-presidents: Sir Frank Dyson, D.Sc., LL.D., F.R.S., Royal Observatory, Greenwich; T. Smith, M.A., F. Inst. P., National Physical Laboratory; R. S. Whipple, M.I.E.E., 15, Creighton-avenue, Muswell Hill, N.W.10; hon. treasurer, Major E. O. Henrici, R.E., 3, The Terrace, Barnes, S.W. 13; hon. secretaries: (*a*) business secretary, Professor Alan Pollard, Imperial College of Science and Technology, South Kensington, S.W. 7; (*b*) papers secretary, F. F. S. Bryson, Glass Research Association, 50, Bedford-square, W.C. 1; hon. librarian, J. H. Sutcliffe, 10, Clifford's-inn, Fleet-street, E.C. 4; editor of "Transactions," Dr. J. S. Anderson, 5, Uffney-park, Teddington; Council: J. S. Anderson, Instructor Commander T. Y. Baker, R.N., W. M. Brett, Professor F. J. Cheshire, R. W. Cheshire, R. S. Clay, H. H. Emsley, P. F. Everitt, Dr. J. W. French, Miss L. M. Gillman, Mrs. C. H. Griffiths, Dr. L. C. Martin, Professor A. W. Porter, F.R.S., F. Twyman, and A. Whitwell.

18-H.P. "CHERUB" AERO ENGINE

THE BRISTOL AEROPLANE CO., LIMITED, BRISTOL, ENGINEERS



A Small Two-cylinder Aero Engine.

THE growing interest in aircraft of the glider type equipped with an engine of comparatively low horse-power has been carefully watched by the Bristol Aeroplane Company, Limited, and for the past fifteen months its aero engine department has been developing and perfecting a small 1070 c.c. flat twin air-cooled unit suitable for this purpose. Twelve or fourteen years ago aircraft pilots were seriously handicapped by the limitations and failures of the small powered engines then in use. Engines of converted motor cycle type—as most of them were—they were probably quite satisfactory on the road when they were rarely run for more than a minute at full throttle, but for aircraft they were unreliable. In the development of its new type, the Bristol Company has insisted upon sound reliability and claims to have produced an extremely robust engine. The new engine has been subjected, we are informed, to exhaustive experiments on the Froude test bench under conditions exactly similar to those demanded by the Air Ministry for large aero engines, and continuous ten-hour non-stop power tests have been carried out on the Froude dynamometer.

Two types of the engine have been designed—one with the driving boss running at crank shaft speed, to be used in conjunction with a chain-driven propeller; and the other with a 2-to-1 reduction gear enclosed in the crank case. The first named type is illustrated herewith. All the valve mechanism is entirely enclosed, ball and roller bearings are used throughout, and the lubrication is wholly automatic. The engine, it is claimed, can be left to run for long periods at the full rated power, without attention or adjustment—special measures described below having been taken to deal with the attendant troubles usual with overhead valve air-cooled engines. The following are the leading particulars of the engine:—Bore, 85 mm.; stroke, 94 mm.; R.A.C. rating, 8.95 brake horse-power; rated horse-power, 18 at 2500 revolutions per minute; weight of engine complete, 85 lb.; petrol consumption per hour, 12 pints; and lubricating oil consumption per hour, ½ pint.

The cylinder construction calls for attention as the head is detachable, and of aluminium alloy, the sparking plug bosses being bushed in bronze. The valve mechanism is also of special interest. A single cam shaft with four integral cams, and driven by gearing from the crank shaft, lies inside the crank case. The cams operate fingers, which in turn operate rocking shafts enclosed in tubes. The rocking shafts are returned by coiled springs, and the mechanism is such that when the cylinders warm up there is no increased clearance between the rocking shafts and valves. Twin concentric springs are used for the valves. The whole mechanism is enclosed and automatically lubricated.

The crank shaft is supported on three ball bearings and a thrust bearing. The connecting-rods are threaded on to the crank shaft, and run on case-hardened crank pins with with $^{7}/_{16}$in. rollers. The big end of each connecting-rod has a case-hardened bush inserted. Special attention has been given to the connecting-rod roller bearing assembly, so that very long life may be guaranteed under continuous working conditions. The crank case is a one-piece casting, pierced at the rear end with a large aperture, which provides for the connecting-rod assembly being inserted complete.

The lubricating oil is positively delivered to the timing gears, cam shaft, rocker mechanism, &c., and pressure feed is directed on to the connecting-rod assembly, from which the cylinders are lubricated on the "splash" system. The charge of lubricant, approximately 1 gallon, is carried in the sump provided in the lower part of the crank case, which floods the plunger pump. Ignition is effected by means of a British Thomson-Houston Company's twin-cylinder magneto, which is driven by gearing from the crank shaft. The mixture is provided by a "Zenith" carburetter, drawing hot air from the exhaust pipe.

The Ideal Home Exhibition

To the thoughtful person visiting the Ideal Home Exhibition, which opened at Olympia on March 1st and will close on the 24th inst., a point much emphasised is the extent to which we rely on the engineer for the amenities and comforts of life. On a very large proportion of the stands the work of the engineer is directly visible, and in the case of a not inconsiderable proportion of the remainder his influence is indirectly in evidence. It would be quite impossible, therefore, to attempt to give a list, much less a detailed account of all that is there which might be of interest to engineers. Such a course, besides calling for far more space than we can afford to give to it, would possibly also prove wearisome to our readers, for in many cases the same things—or very nearly the same things with but small differences—are being exhibited by numerous different firms. As an example of what we mean we may instance power-operated vacuum cleaners. They are met with on every hand, and the visitor is invited to watch them while they swallow well-nigh incredible volumes of dust. It would be out of the question to refer to them all and to differentiate between their respective attributes. They are one and all of them ingenious contrivances and greatly in advance, mechanically, of their hand-worked prototypes.

There is an astonishing number of exhibits in which electricity is made use of in one way or another, and it would be hopeless to try and particularise regarding them, but many of them are of considerable interest. Then, again, the number of exhibits of articles and apparatus having to do with heating and lighting is very large, and their types are very diversified. There are domestic boilers, operated in many different ways, for the continuous supply of hot water, central heating equipments, electric heating appliances of all sorts and kinds, fuel stoves in large variety, cooking stoves and devices of a multiplicity of designs, and several self-contained electric lighting sets, some of them of quite minute size yet evidently serviceable. Lavatory accommodation is well represented, some of the wash-hand basins and baths having a most luxurious appearance, while there are exhibits of automatic washing machines which well deserve attention, and of plants for the manufacture of gas for domestic use.

Wireless exhibits there are in bewildering profusion, and there are also ordinary telephone equipments. Among other things which are on view there are lifts, refrigeration equipments, sanitary appliances, pumps, concrete making and handling equipment, water softeners, disinfectors, filters, aerated water machines, lawn mowers, garden tools, stair treads, steel cupboards, casements, electrical fittings of every description, fire-grates and ranges, bedsteads, lamps, ironers, sewing machines, articles in stainless steel, aluminium utensils, typewriters, &c. &c.

Of its class the Exhibition can, we think, be called excellent, but if it be necessary to have everything shown in order to possess an "ideal home," then that home will have to have the proportions of a mansion, and it will certainly be far from cheap!

Variable Power Hydraulic Riveting Machine.

THE riveting machine illustrated by the accompanying engraving has been recently designed and constructed by Henry Berry and Co., Limited, of Leeds, to the order of Holdsworth and Sons, Limited, boilermakers, Bradford, and forms part of a large plant which has just been installed in the last-mentioned works. The machine in question is noteworthy on account of the large range of power obtainable at the snaps. It is, in fact, possible to get seven different powers on the rivet varying from 20 to 130 tons. This range of powers is obtained by means of three telescopic rams controlled by stop valves in such a manner that any combination can be utilised. The stop valves having been set for the power required, the actual riveting operation is controlled by the manipulation of a single hand lever.

BERRY VARIABLE-POWER RIVETING MACHINE

This large range of powers is, of course, of considerable advantage to the boilermaker, as it allows him to choose a power best suited to the size and type of rivet in hand, thus avoiding the likelihood of damaging the plates by using too much force. Further, considerable economy is, naturally, effected when doing small or medium work. The valve arrangement includes a water-saving device by means of which the snaps are brought up to their work, and the cylinders filled with low-pressure water. The high pressure is then automatically applied when the snaps meet any resistance. There is also a timing arrangement which is adjustable to give any pre-determined "dwell" on the rivet after it has been closed. It will also be noticed from the engraving that three pressure gauges are fitted in front of the operator to enable him to see at a glance exactly what power he is applying to any particular rivet.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Unsettled Market Conditions.

BUSINESS on the Birmingham iron and steel market to-day—Thursday—was small and unsettled conditions prevailed. On the surface the market looks strong, but it no longer has the steady undertone which was its most hopeful feature when the year opened. The effects of the continental position, as evidenced through the scarcity of coke and pig iron and the rising prices, are being more generally felt, and the makers dependent on the basic materials for their products are finding the reaction in advancing quotations. Stringency in all iron and steel departments continues to increase. Materials of every kind have become scarcer, and quotations, high as they are, cannot be relied upon for the coming days. Manufacturers are hampered by the lack of raw material, and are feeling still more acutely the pinch resulting from the shortage of fuel supplies. The basis industries maintain active conditions, but stability is lacking, and nothing like the same confidence can be felt as was experienced at the opening of the year, when buyers were showing a tendency to do something like continuous business. In the absence of any immediate prospect of relief in the situation created by the French occupation of the Ruhr, the outlook is growing more discouraging. The position is too full of uncertainty to warrant expansion of business beyond immediate requirements. The present high prices are looked upon as artificial and liable to collapse as soon as the situation clears abroad.

Northamptonshire Pigs Disappear.

The pig iron shortage has become more acute and Northamptonshire irons have for all practical purposes disappeared from the market, while forge qualities of Derbyshire or Staffordshire make are almost unprocurable. The prices mentioned for small emergency parcels of Northamptonshire pig may be paid by users who are anxious to escape from a tight place at any cost, but nobody would think of paying them in the ordinary way of trade, and it would be misleading to reproduce them. Derbyshire and Nottinghamshire irons are scarce and strongly held. Early in the week the price was raised by 2s. 6d. per ton to £5 for foundry material, while to-day some sellers require £5 5s. There is naturally a good deal of disparity in prices, but so far as any balance can be said to exist, Derbyshire forge prices seem to have settled at about 97s. and No. 3 foundry at 100s. Offers both below and above these figures are reported. North Staffordshire makes are approximately 5s. above those of Derbyshire. Many of the prices now being quoted are intended to discourage buying, as producers have their output booked as far ahead as they care to go, and there is no prospect, with the sustained demand for fuel from the Continent sending up coke in price, and making it more and more difficult to obtain for home use, of output increasing. It is reported that in some districts the production of pig iron has already been reduced, and athough in the Midlands no furnace has yet been damped down it cannot be long, if present conditions continue, before this begins to take place. It is, of course, the coke factor which makes pig iron so dear, and as soon as it disappears smelters are prepared to drop prices in a corresponding degree.

Blast Furnace Coke Supplies.

The scarcity of blast furnace coke continues to increase owing to the temptation offered by the keen demand for export to the Continent. There is a difference of something like 15s. or 16s. in the price of coke at ovens for the home trade and coke at ports for export. Many extravagant statements are in circulation as to the prices which are being paid by continental competitors, the scale ranging up to 67s. 6d. f.o.b. So long as export demand lasts values will be maintained at a high figure. If blast furnace owners who have made their contracts for coke are to be subject to the vagaries now developing in the market, they will find it anything but an easy matter to fulfil the engagements into which they have already entered. Smelters complain that they are not getting the coke which they require to keep their plants going, and which they say they were led to expect would be forthcoming. Blast-furnace managements that are not in the fortunate position of having their own coke ovens must either submit to be crowded out or must face week by week the harassing task of carrying on with hand-to-mouth supplies of fuel picked up here and there at whatever price the seller likes to charge.

Rising Values of Finished Iron.

Prices of manufactured iron are, in sympathy with pig iron, moving upward though not to the same extent. Makers of small rounds, hoops and other miscellaneous irons are swamped with orders, and most of the local ironworks have sufficient orders booked to keep the plants in operation going for some weeks. No firm, however, in any department of the iron trade will accept any serious commitment beyond the orders already in hand. Marked bars remain the one stable spot in the market. Their standard of £13 10s. is the same to-day as it was nearly twelve months ago, and the mills are well employed. Staffordshire crown bars are dearer on the week, and were quoted up to £12 on 'Change to-day. In some cases even this figure was plus carriage. The Lancashire price is £12 10s. Iron strip has advanced to £12 from £11 10s., which was last week's accepted figure. A perceptible slowing down has disappointed expectations in the nut and bolt industry. Local bar mills which cater for its requirements, ask £11 and upwards. Lancashire rollers are ready to do prompt business at £11 10s., but they will not book forward. The absence of continental material and the high price of local bars is stated to be the reason for the falling off of business in the nut and bolt trade.

Sheets.

Galvanised corrugated sheets, 24-gauge, are still quoted at £19 to £19 10s., according to specification, but there is but little being done at such prices, and manufacturers are not eager to commit themselves under present productive conditions. Black sheets are quoted £13 10s.

Failure of Continental Supplies.

The tightness of the market is enhanced by the practical cessation of supplies from the Continent. The disposition of French and Belgian firms to repudiate their contracts on the ground of *force majeure* is increasing. In a few instances where pressure has been brought to bear small quantities have been obtained, but delivery is dribbling and seems likely soon to dry up altogether. It is said that many continental concerns which have sold iron and steel to consumers in this district make no bones about going back on their contracts. In the circumstances which have arisen it is quite understandable that punctual fulfilment of contracts is not possible, but nothing can justify the way in which the dislocation is being exploited, according to reports that are now prevalent, by some of those who are under engagements to buyers in this country. Millowners in Staffordshire who had relied upon importations of crude material and semis from the Continent to keep their plant going are under the necessity of making replacements from home sources at much greater cost. It is some satisfaction to know that the Management Committee of the London Iron and Steel Exchange is taking the matter up.

Strong Position of Steel.

The steel market continues strong with advancing prices, the drying up of continental supplies being a favourable factor. On 'Change in Birmingham to-day —Thursday—definite advances on last week's prices for some descriptions of steel were obtained. Soft billets could not be got under £9, and for high carbon billets £9 10s. and upwards was required. Heavy steel strip fetched £11 15s. to £12. The associated makers have formally raised the basis for Staffordshire hoops to £12, a step which had been anticipated in market quotations. Small steel bars make £10 15s. to £11. Prices of joists, angles, and plates in this district have not been further advanced, though in a few cases producers have been able to secure special terms. The advance by Northern firms of 10s. tends to strengthen the Midland position, but contractors in this area are none too well employed. Constructional contract business is subject to keen price cutting, owing to the large number of firms which came into it during the boom time that immediately followed the war. Manufacturers and holders of home steel products are in a stronger position than ever as far as the market is concerned. But the increasing scarcity of raw material prevents them making the most of the opportunity. For the present the mills, as far as their capacity has come into operation, are full of work and booked several weeks ahead.

Scrap.

Scrap of all kinds is scarce and dear. Scrap steel, where available, can be sold readily at £4 10s., but the price is stiffening under the influence of the steel shortage in other districts.

Staffordshire Miners' Wage Reduction.

The ascertainment for wages for the miners in the Cannock Chase and Pelsall districts for March and April as based upon the output and costs for November and December last, results in a reduction of 4d. per shift for stallmen whose wages fall from 9s. 10d. to 9s. 6d. The percentage addition to the standard wages is fixed at 45.21 per cent., as against 49.61 per cent. for the past two months. A proportionate reduction takes place in the wages of other grades of mine workers ranging from 1d. in the case of boys to 4d. for stallmen.

Decrease of 4306 in Midland Unemployed.

The latest unemployment returns for the West Midlands area show that the steady decrease in the number of workless which has been going on for some weeks past continues. For the week ended February 26th the aggregate number of unemployed was 146,261, as compared with 150,567 for the previous week, a decrease of 4306. The reduction in Birmingham was 1511. The numbers registered at the various Labour Exchanges in the principal towns are Birmingham area, 48,652; Coventry, 4439; Cradley Heath, 5016; Darlaston, 2197; Dudley, 5002; Smethwick, 6574; Walsall, 6938; West Bromwich, 3635; and Wolverhampton, 9404.

Midland Iron and Steel Wages Board.

The report of the Midland Iron and Steel Wages Board shows that the number of firms which are members is 86, 42 of them having works in South Staffordshire and Shropshire. The receipts for the year amounted to £4984, of which the operatives contributed £2366—and the expenditure £5786. The bank balance from the previous year had been extinguished, and a further debt incurred of £299.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER, Thursday.

General Outlook.

THERE have been considerable changes in the markets since I last wrote, and in almost every case the movement has been towards higher prices. In some instances prices are now getting rather on the extravagant side, and sober people are beginning to be a little nervous about them. It is, of course, true that the advances recently made are not in accordance with the measure of trade improvement, although there is no doubt we have some growth in the home demand for iron and metals; but the main reason for the advance is to be found in the fact that consumers of material in Scandinavia, Holland, Spain, &c., and in the East, are no longer able to deal, as they did, with the Continent. Should the continental trade be put into order again, there is not trade enough in this country to prevent the markets from falling back. This is particularly the case in regard to iron and fuel.

Metals.

The very sharp advances in the non-ferrous metal market seem mainly to be associated with active buying in America. Both in copper and tin it is the American buying which is at the bottom of the rise, and one is a little doubtful whether this stimulating cause will continue. It may, however, be admitted that the domestic consumption of copper in America has increased very rapidly of late, and there is a larger consumption in this country; but the latter may be merely a result of the placing of orders here which would in ordinary circumstances have gone to Germany. This is, of course, a matter of satisfaction to us, but it need not affect the total consumption of copper. The speculative movement has been encouraged by the rise, and is perhaps accountable for part of it; and there is no indication yet that speculators in copper are afraid of the future. The prices of copper, that is, of standard and best select, are still moderate compared with those for iron and lead. Engineers have some right to complain that although the prices for manufactured copper and brass have for so long been too high in comparison with the raw metals, yet the full amount of the recent advance has been added to these prices. Strong copper sheets and bottoms are now £8 per ton higher than they were in January, and tubes have been raised to about the same extent. The readjustment of prices in this section of the market so as to bring them into proper relationship with raw metals has been delayed far too long, and consumers are naturally very dissatisfied with the present position. There has been considerable excitement in the market for tin, but it is now a grave question whether prices are not going too high. A certain amount of nervousness seems to be developing, and this may lead later on to the beginning of a "bear" campaign. American buying was at the bottom of the advance, and the reports which are coming to hand seem to indicate that American consumers are not willing to follow the market much further. It is, of course, possible that further advances will occur, but if so the price will be high enough to tempt a further liquidation of the reserved stocks in the East. The market for lead has been very firm, and prices are rather higher, but the increase seems to be mainly in sympathy with a rapid movement in copper and tin. In spelter there has been scarcely the same very optimistic feeling, but the demand from consumers has been good, and there is not a very heavy supply pressing upon the market here.

Pig Iron.

The market here for pig iron is in a curious condition, and one does not quite know what to make of it. Prices are, of course, very firm and tending to go higher, but at the same time there is less business moving, at any rate in the foundry iron section of the market. Those ironfounders who have used up all their stock are, of course, compelled to pay the current prices, and if they are not amongst the favoured customers of a furnace they may have to pay 115s. per ton. In special cases, however, No. 3 Derbyshire can be bought on a basis of 100s. per ton at the furnace, or 109s. to 110s. per ton delivered. Those ironfounders who have still some cheap iron to come in seem to be standing off and waiting. When they look up their last purchases they find them at 90s. to 92s. 6d. per ton delivered, and they naturally hesitate to pay the advance, at any rate until they are compelled. As the Midland furnaces can now get equal to 105s. on trucks by sending their iron to Cleveland they are fairly firm; and as it is not yet clear that the limit in the rise in coke has been reached, furnaces are not very much disposed to book iron far ahead even at to-day's prices. There has been a further jump in East Coast hematite iron, and this metal, together with Scotch, seems now to be almost out of the reach of the Manchester ironfounder.

Finished Material.

The demand for sectional steel is reported to be rather better, and there is a tendency for sections to come up to the price of plates. There is, in fact, no reason why they should be sold at a lower price unless it be in the case of rails and joists which might be ordered in large quantities for one section. The Lancashire steel hoop manufacturers have revised their prices, which now stand at £13 15s. per ton for soft steel hoops and £15 5s. per ton for best steel hoops. The price of iron hoops is £15 per ton, and of Crown bar iron £12 10s.

Scrap.

There is a decided improvement in the market for scrap materials, but the prices obtainable here are not yet fully in accordance with the rise in new materials. Dealers are now trying to get 85s. per ton for heavy steel melting scrap on trucks in Lancashire, and the Sheffield consumers have recently paid a price about equivalent to this. For heavy wrought scrap delivered to the works dealers ask 90s. per ton, and with bars at £12 10s. one cannot say that the price is too high; but iron manufacturers are not quite educated up to it yet. Foundry scrap is in better demand, and the accumulations are getting less, but good broken machinery scrap is still very cheap as compared with pig iron. Dealers seem proud of having got as much as 95s. per ton for it; but this is very much below its value when compared with Derbyshire No. 3.

BARROW-IN-FURNESS, Thursday.

Hematite.

The position in the hematite iron trade is improved, for the representations made to the exporters of coke have had effect, and there is a better and more

regular delivery. The Furness district suffered more than West Cumberland, but both were held up. Business is very brisk considering, and there seems no reason to doubt the statement that the production in this district is unequal to the demand. Makers are still wary about putting more furnaces into blast for two reasons. If one cuts out the increased trade resulting from the French occupation in the Ruhr, the present number of furnaces would be quite sufficient, and if the bottom was to drop suddenly out of this trade, makers, if they had increased their output, would find themselves forced either to damp down or make and put into stock, and this would not be advisable, for if the demand eases there may be a falling in prices. Another reason is the still important difficulty of coke deliveries. The Continent continues to take a considerable amount of iron, and the home consumption is increasing. The latter improvement is due to the better tone in the engineering and shipbuilding trades. There have been shipments of iron from Barrow for Tréport, South Wales, Antwerp, &c.

Iron Ore.

The iron ore trade is better again, and it is hoped that it will steadily improve as time goes on. Most of the output is used locally, but there have been more shipments lately, including some for France. There is a better tone altogether in the iron ore trade than there has been for some time. Foreign ore is in steady demand, and there will be an improvement in imports now that the stocks are being reduced.

Steel.

The steel trade is moderate, generally speaking. Barrow is better situated than West Cumberland, which has only had its rail mill partially employed. The Barrow rail mills are still engaged, and will be for some time yet. There are regular shipments of rails and fish-plates to Liverpool from Barrow for transhipment. The hoop and bar mills are fairly active, and the foundries are moderately employed.

Shipbuilding.

As was hinted at a few weeks back, there is better news in the shipbuilding trade. Vickers Limited have been successful in securing an order from France, Fenwick and Co., Limited, of London, for two steam colliers 280ft. long and possessing a speed of 10 knots. These steamers will be steam-driven.

SHEFFIELD.

(From our own Correspondent.)

Heavy Steel Trade Flourishing

THE demand for mild steel continues to increase at a very satisfactory rate, and Sheffield, which is the great centre for the production of this material, is feeling the full benefit of the improvement. The growth of business has been considerably stimulated by the troubles in the Ruhr, which have not only put a period to German competition, but have seriously reduced the ability of France and Belgium to accept trade from outside countries. An example of the way in which conditions have changed is furnished by a letter received by a Sheffield firm from a continental merchant, who has an important business in steel with various countries. He states that hitherto his orders have gone to Germany, as the Sheffield quotations have been too high. Now, however, that Germany is no longer able to accept his orders, he proposes to transfer his custom to Sheffield, and he expresses the hope that British prices will be kept at as reasonable a level as possible, so that he may continue to trade with this country. The home demand for these qualities of steel is also very good, Staffordshire and South Wales especially taking large quantities. The result of all this is that the mild steel trade is enjoying something in the nature of a boom. The past week has seen a great increase in the number of orders and inquiries received by the East End of Sheffield and by Rotherham. Most of the furnaces—some of which have only been recently erected, and have had to wait a couple of years for employment—are now working at their full capacity. Some of the works are getting into arrears with deliveries, and display no anxiety to take additional contracts. It seems not unlikely that before long the demand for steel will be in excess of the means of supply, greatly as these have been enlarged.

Some Busy Departments.

The stream of orders for railway steel continues unchecked, and, although the tire-making plants are not yet fully occupied, they are rapidly filling up with work, and their prospects, as well as the prospects of those branches engaged in the manufacture of springs, axles, and buffers, are considered quite good. The Master Cutler, himself a manufacturer of railway material, and one of the most consistent optimists in the city, said last week that every day brought increasing evidence of an improvement in Sheffield's trade. He added that the city was consolidating its position in those markets, especially South America, which it had very largely lost owing to war conditions. The rolling mills are now well employed, and there has been a great improvement in the wire trade, with the result that the rod mills at Templeborough and elsewhere are quite busy. There have been advances in prices of both basic steel and wire rods. Pig iron is still very scarce, and higher rates are being demanded for it, and also for the coke with which the blast furnaces are fired. For coke for export, it is said that as much as 45s. has been offered at the ovens, but even at that figure the available supplies are very small. A new blast-furnace, capable of turning out 1000 tons per week, is to be built at the Renishaw ironworks.

The Lighter Steel Trades.

There is only a moderate amount of improvement in the crucible and high-speed steel branches. The progress of engineering in the country is all to the good of these sections of Sheffield trade, and must result in an increased demand for fine steels, but so far progress is slow. In files, engineers' small tools, and hand tools, there is a good deal of stagnation, which is to some extent modified by the requirements of collieries. While a few firms are doing fairly well, others are very badly placed, and the orders that are given out are not of any great bulk.

Cutlery and Plate.

The position of these trades continues unsatisfactory. The cutlery manufacturers are perhaps doing more than they were twelve months ago, but the hopes of a substantial revival, based on the brisk demand that was experienced about Christmas, have not been realised. There is still a good demand for stainless table knives, and the orders placed are of considerable magnitude, but prices are severely cut. Leading firms are sometimes unable to accept orders at the prices offered, and the trade goes to little masters, who are able to underquote to the extent of 10s. or more per dozen. There is a better demand for Sheffield scissors, and fairly large quantities are being produced and sold. The pocket-knife and razor branches are the slackest, and are having a very lean time. Although imports from Germany are stopped at present, there are still large quantities of German goods in this country, and the competition is very keen.

Supporting Home Industries.

The question of choosing between home and outside firms is one that often confronts corporations when contracts for municipal supplies have to be given out, and different authorities vary in the courses they adopt. Recently Sheffield lost a contract for tram rails for Hull because its tender was not the lowest, and the work was given to Belgium. Now, a case has arisen in which Sheffield sent in the lowest quotation, but has still been unsuccessful. The Corporation of Edinburgh invited tenders for the tops and fittings of a large number of tramcars, and the Tramways Committee provisionally accepted the offer of Cravens, Limited, of Sheffield, which exceeded £10,000. In the full council, however, the need of providing work for Edinburgh people was argued so strongly that eventually a local tender was accepted, at a considerably higher price than that of Sheffield.

In the Mining World.

There are several interesting points about colliery development to chronicle this week. Mr. J. P. Houfton, in a speech at Mansfield, has been pointing out the need for an increase in the coal output. He states that there is a great deal of leeway, in the matter of new sinkings, to be made up, and that if trade continues to improve as it is doing, there will be a coal famine before all the arrears are overtaken. He predicts that in the next ten or fifteen years Mansfield will be the centre of a new population of 40,000 within a radius of ten miles or so. Mr. Houfton is chairman of the Hatfield Main Colliery, one of the newest in the district, and at the annual meeting he stated that the output was now 7000 tons per week, and was increasing. The permanent screens were nearly finished; it was anticipated that they would be ready at the beginning of April, and this should result in an improvement in the selling value of the coal. The company is very anxious to build new houses for its employees, as two or three hundred additional dwellings would enable it to double the present output with very little extra cost, and it is arranging with the Public Works Loan Board and the Trade Facilities Board to advance it money to assist in the building schemes.

Water Troubles Overcome.

Mr. Houfton mentioned that at Hatfield Main they had over 11,000 acres of coal, of which the Barnsley seam alone would give the colliery a life of over ninety years. The Kents thick seam had been proved at a thickness of 5ft. 10in. in the shafts, but as to whether this seam was available for the greater portion of the royalty they would know more when the Armthorpe and Thorne sinkings, now in progress, proved the same seam in their shafts. Mention of Thorne reminds me that the sinking of this shaft is making good progress. It has been in progress a good number of years, and has been greatly interfered with by water troubles. Now, however, two small seams of coal have been found at depths of 511 and 512 yards respectively, and, although these are not of considerable commercial value, the discovery shows that the water-bearing strata have been practically overcome. It is anticipated that the Barnsley bed will be reached, at a depth of about 1000 yards, in the summer of 1924.

Various Items.

Sheffield Education Committee has just started the erection of two new schools, one of which will cost £18,811 and accommodate 848 scholars, while the other will cost £25,283 and accommodate 840. The schools, which will be of the one-storey type, have been designed by the city architect (Mr. F. E. P. Edwards), and the contractors are T. Roper and Son, Limited, and Messrs. Reeves Charlesworth. At Rotherham, a Ministry of Health inquiry has been held into an application of the corporation for an extended time in which to complete a service reservoir at Kimberworth. Ten years was originally granted, but the war interfered with the progress of the work, and now a further five years is asked for. The reservoir at present has a capacity of 1,000,000 gallons, but it is considered that within the next five years the necessities of the district will call for its full capacity of 3,000,000. Local authorities in the Chesterfield district are considering a suggestion of the Ministry of Health that they should adopt a joint scheme of water supply for an area serving a population of about 140,000. A representative committee has been appointed, to which the water engineers of the Chesterfield Corporation and Rural Council will submit a scheme, with particulars, showing the additional supply required at present and estimated to be required in ten years, financial liability, &c. At Barnsley, public men are agitating for a main line train service and a new central station. For the latter, the corporation is willing to provide a site on its tip in Queen's-road. A Derbyshire railway matter of interest is a movement for petitioning the L. M. and S. Company to construct a line connecting Ambergate, Wirksworth, and Ashbourne with Sheffield and the North.

NORTH OF ENGLAND.

(From our own Correspondent.)

The Trade Position.

TRADE improvement in the North of England is well maintained. Increasing activity is reported in most industries, and plant which has long been idle is gradually being put into operation once more. At the same time progress towards a normal state of affairs proceeds somewhat slowly. In the iron and steel trades, for instance, a tremendous handicap has sprung up owing to the acute shortage of fuel just at a point when there was a prospect of a return to more prosperous times. Although extensive orders are circulating, manufacturers are prevented from taking advantage of the golden opportunity because they are unable to expand their outputs owing to the lack of fuel. As a result prices have moved up rapidly, and in the end are likely to prove detrimental to a trade revival. The evils of inflation are too clearly before the ironmakers, but they find themselves carried helplessly along on an irresistible tide of events, in which they are constantly struggling to keep abreast of the ever-rising costs of production. How rapid has been the advance in prices may be judged by the fact that since the beginning of the year No. 3 Cleveland pig iron has gone up from 92s. to 125s. per ton.

Cleveland Iron Trade.

The Cleveland pig iron market presents few new features. The shortage of iron is still very acute, and makers are fully sold for some weeks ahead. The upward movement in prices still continues, and traders are wondering when it will cease. The course of events has disturbed all calculations, and the phenomenal cost of pig iron and fuel is gravely handicapping engineers and foundry men. Some of the blast-furnaces which it had been hoped to start this week are still cold, and the three lighted up last week have not had time to exercise any influence on supplies of iron for the open market. For the small odd lots that become available there is keen competition, and buyers have to submit to increasing quotations. The general market quotation for No. 3 G.M.B. Cleveland pig iron is now 125s. On this basis No. 1 is put at about 130s., No. 4 foundry 120s., and No. 4 forge 115s.

Hematite Pig Iron.

The position in the East Coast hematite pig iron trade is also very difficult. There is a brisk demand on both home and export account, but makers are practically sold out to the end of April. Prices have advanced, and 120s. is now the general quotation for mixed numbers for May-June delivery, while No. 1 is put at a 1s. per ton premium. For any prompt iron possibly a higher figure might be realised.

Iron-making Materials.

Foreign ore prices are steady, but a lull seems to have set in, consumers having apparently covered their present needs. Sellers, however, show no sign of weakening, and with freights advanced the price of best Rubio ranges from 25s. to 26s. per ton c.i.f. Coke producers have no spare supplies, having heavy home and foreign commitments, and however pressing they are unable to meet any extra calls from the ironmasters. They are, however, renewing old contracts at prices ranging from 38s. to 40s. per ton delivered at the works.

Manufactured Iron and Steel.

Encouraging accounts are given of the manufactured iron and steel trade. A huge volume of inquiries is pouring in, and makers have about as much work as they can cope with until the end of April. But the outlook is so uncertain, and costs are rising so rapidly, that current orders are scarcely covering costs of production, and steel makers are not inclined to commit themselves far ahead until conditions become more stabilised. Quotations remain very firm.

Iron and Steel Exports.

The shipments of pig iron, manufactured iron and steel from the Cleveland district during February showed a substantial drop as compared with those of January, the total being 66,242 tons as compared with 80,697 tons. There were, however, three fewer working days. Notwithstanding the urgency of the home requirements the exports of pig iron showed little diminution, the February total of 39,406 tons comparing not unfavourably with the January total of 41,308 tons. Nearly 3000 tons less pig iron was shipped coastwise, but an increase was recorded of 935 tons in the foreign shipments, which totalled 27,476 tons. The effect of the Ruhr invasion is reflected in the pig iron exports to Germany, from 2185 tons in January to 8019 tons in February, and although the American business is petering out, the February shipments to the United States reached 6258 tons compared with 5342 tons in January. A big decline was recorded in the exports of manufactured iron and steel, of which 26,836 tons were shipped in February as compared with 39,299 tons in January. The Indian trade fell away considerably, only totalling 8248 tons as against 12,762 tons in the previous month.

The Coal Trade.

The Northern coal market is exceedingly firm in all respects, and there are no visible openings or opportunities for bargains in any direction. The collieries are, without exception, very well sold ahead, at least as far as June, so that recent quotations are not only fully sustained, but are inclined to move forward a little. The buying, as well as the inquiries from Germany, continues to be

on extensive lines, and as yet shows no signs of falling away. As there is apparently no limit to the quantities of fuel the German market is able to absorb, and sterling credits in this country are still said to be ample to cover current commitments, there is every likelihood of shipments proceeding regularly and smoothly. The orders and inquiries from other countries are not quite so heavy as they might be, but there are evidences of movement from Scandinavia, France, Belgium, and Italy. Advices from the Continent indicate that the agents for America are strenuously engaged in trying to fix up large contracts for shipment from American ports, and up to a quarter of a million tons weekly is said to be easily available for shipment to Europe, but the fixing of shipping presents some considerable difficulty for them, and the competition is not regarded seriously in this district. The outlook in the North of England is considered to be quite satisfactory for a while ahead, and many of the shippers are quite satisfied with the present trend of the market. Northumberland steam coals of every sort are very firm, and in the case of smalls are firmer and inclining upward. The Durham market is strong in all directions. The collieries producing best and special gas coals are absolutely sold out for a while ahead, and refuse under present circumstances to look at anything below current quotations. Coking coals are scarce and strong, while bunkers are a firm market for any date of shipment. The coke position is strong for foundries, and is still improving for gas coke.

SCOTLAND.

(From our own Correspondent.)

Shipbuilding.

THE total tonnage launched from Scottish yards during the month of February only amounted to nine vessels of 20,996 tons aggregate. Of that total, five vessels of 18,846 tons were launched from Clyde yards. The output is well below the average for the month, and with the figures for January also of meagre dimensions the industry has made a poor start for the year. A good number of contracts are on hand, but only a limited number have been commenced. Inquiries still come along, but increased costs mean higher tenders, and prospects of additional orders are not rosy. Contracts announced during February include two cargo steamers of 8400 tons each. It is stated that tenders have been invited for four steamers of 18,000 tons each for the P. and O. Company. Included in the launches for February were the following:—The Delilian, cargo steamer, 6440 tons, for Frederick Leyland and Co., Liverpool; Clan MacFadyen, 6000 tons, for the Clan Line; Araby, ss. motor vessel, 4936 tons, for David MacIver and Co., Liverpool. It is said that owing to advancing costs of production shipbuilders are withdrawing offers based on cheaper costs.

Pig Iron.

Apart from a rise in prices there has been no change in the pig iron trade. Outputs are small, and are quickly disposed of, and demands continue to expand. The number of furnaces in blast may be added to, but meantime the production is stretched to the utmost limit, and prices rise steadily.

Steel and Iron.

The market for steel is quieter. Prices continue to harden, and buying is becoming more and more cautious, with the result that the recovery in the trade has been hampered. Orders already booked will provide employment for some time, but prospects of additional business are dim. Boiler and ship-plates with sectional material were advanced in price early last week, and this advance has been followed by a rise in black sheets of from 10s. to 15s. per ton, making a total increase of 15s. to 35s. per ton since the beginning of the year. Bar iron remains steadily fixed at £11 per ton for home delivery, and almost the same figure for export. Most sizes are in good demand on both home and export account, and the works are in a much better position than they were a very few months ago. Re-rolled steel bars have good export demands round about £9 10s. per ton. A scarcity of billets presents a serious handicap to outputs. Scrap metal of all kinds is very scarce, and both the lack of supply and soaring prices are hindering the growth of trade. There are still indications that overseas markets are now more in touch with home producers, and that business can be got at a price.

Heavy Export Coal Demands.

Almost all available supplies of Scotch fuel are quickly disposed of for shipment, any lots coming on the market realising full current prices or more. The collieries are almost fully booked for March, and it is reported that orders have been booked up to the month of August, and even further ahead. The bulk of the buying is still for Germany, but France, Belgium, and Italy are now more active. The pressure for washed materials has been particularly heavy, and prices of these qualities are much firmer. The difficulty in securing prompt cargoes has caused considerable congestion at the loading ports chiefly on the East Coast; but aggregate shipments are of good bulk, nevertheless, amounting to 329,041 tons against 305,263 tons in the preceding week, and 251,616 tons in the same week last year.

Home Coal Market Shortage.

The local industrial demand for fuel has developed very slowly, but the present export boom threatens to absorb even the small amount necessary. Many concerns have not been laying in large stocks of fuel, and some establishments have had considerable difficulty in securing enough fuel to tide them over a very short period. Furthermore, the prices charged are being brought more into line with those current for export. It is hinted that the high prices quoted for British coal for export are already causing some overseas buyers to turn to America for supplies. If that is the case, local fuel may become a little more plentiful and more reasonable in price. The dearer fuel is playing an important part in the advancing prices of steel, a movement which is wholly regrettable in the interests of trade expansion.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Position.

STEAM coal conditions have become perceptibly stronger since I wrote a week ago, and it is scarcely possible to obtain supplies for anything like early shipment. On paper collieries are full up, and in isolated cases where they have any parcels to dispose of they can name practically their own price. At the moment best Admiralty large are anywhere from 32s. 6d. to 35s. per ton, and colliery salesmen will not sell ahead unless they can secure the latter figure. Small coals have also advanced to an extent that was never dreamed of a few weeks ago. Best qualities are generally quoted from 25s. to 26s., but in some instances as much as 28s. is demanded. The inquiry for coals is on a heavy scale from Germany, Belgium, France, and in a lesser degree from Italy, and there is no doubt that a good deal of business is being turned down for the reason that the coals cannot be obtained or that exporters cannot get offers from the collieries. Furthermore, the c.i.f. risks are becoming rather more than the ordinary firm is prepared to undertake, especially seeing that freight rates have shown such a marked advance of late. There is no disguising the fact that many exporters have recently been very badly caught between the rise in coals and the sharp upward movement in rates of freight, and some of them are by no means yet out of their difficulties. In some directions the freight market has gone against the exporters to the extent of anything from 1s. 6d. to 4s. per ton, so that it will be obvious that the average margin allowed for profit when closing business, viz., about 6d. per ton, is swamped. From all accounts the Germans are prepared to purchase further considerable quantities of coal from this country, and so far as France is concerned, it is reported that the P.L.M. Railways have bought half a million tons of large and small coals from this district for shipment during the remainder of the year on the basis of 28s. for the large and 20s. for the small coals. The Swiss railways are also inquiring for supplies of patent fuel, and there is an inquiry from Scandinavia for 20,000 tons of large coal for delivery over the next two months. Rather less has been heard during the past week of American competition. American coals have hardened in price, and rates of freight from the Northern range of ports to European destinations have also improved, so that it is doubtful whether the Americans can do business at anything like the low prices which were reported recently to have been received. American competition, however, is not altogether looked upon with disfavour by the exporter from this district, as it is regarded as likely to have the effect of preventing prices for South Wales coals advancing beyond reason. How long the present conditions are going to last no one, of course, knows, but it is generally recognised that there is a good deal of artificiality and abnormality about them. It may be said with some truth that the market is getting somewhat nervy, and people are seriously wondering how long Germany, France, Belgium and Italy can go on paying the present prices for supplies of coal with foreign exchange rates so adverse. A sudden alteration in the political situation on the Continent would undoubtedly put a very different complexion upon the coal trade. It would be the first to feel the effects, and it is very difficult to say how people would come out of the position seeing that a good many have bought considerable supplies of coal for delivery over the remainder of this year, and, of course, for shorter periods, at what may be regarded as rather high prices.

Coke Supplies.

As the result of the foreign demand there is undoubtedly a great scarcity of supplies of coke, and it is announced that some furnaces have had to close down owing to the fact that producers of pig iron had not covered themselves for their fuel requirements. This matter was recently referred to by the chairman of the Consolidated Cambrian, Limited, at that company's annual meeting, when he stated that the directors took the view that they must not serve Germany, at whatever profit, at the cost of ruin to industries reviving at home. It appears that the Monmouthshire and South Wales Coke Ovens and By-product Works Association has recently had the matter under consideration, and has unanimously approved of the principle that preferential treatment should be given to the home consumer. The members of this Association have been recommended to continue delivery to the South Wales blast-furnaces of the quantities of coke they have been customarily supplying at prices which, while showing a slight increase on the prices ruling last year, are nevertheless within the ability of iron and steel makers to pay.

Tin-plate Bars Advanced in Price.

On Saturday last the South Wales Siemens Steel Association advanced the price of tin-plate bars by 10s. to £8 10s. per ton f.o.b., less 7s. 6d. per ton rebate to the tin works agreeing to the minimum prices scheme. The price of sheet bars also has risen from £7 17s. 6d. per ton delivered South Wales and Monmouthshire to £8 7s. 6d. and for delivery in the Midlands from £8 to £8 10s. The contention of steel makers is that the rise is inevitable as the result of the advance in the price of the raw materials, and the probability is now that the minimum fixed price of tin-plates will be put up.

Miners' Wages.

As the outcome of the recent interview of the representatives of the miners with the Prime Minister, the Council of the South Wales Miners' Federation held a meeting on Thursday last week and decided to call a South Wales conference for the 19th inst. at Cardiff, when a recommendation will be submitted that, having exhausted all other methods to secure an improvement in the impossible wages received by a very large number of colliery workers, the conference should authorise the delegates to the M.F.G.B. conference to be held in London on the 27th inst. to vote for the termination of the agreement, with a view to insisting upon a higher rate of wages.

Current Business.

The inquiry for all descriptions of coals has been on a very active scale, and it is very difficult exactly to gauge prices, as most of the collieries have no coal to sell for some weeks, and they decline to make any offers for delivery ahead. At the moment best Admiralty large are firm at 32s. 6d., but this figure is indicated also for leading Monmouthshire large coals, as these grades are so fully booked up. For any further business colliery salesmen state that they will not look at less than 33s. 6d., and in one or two cases 35s. for best Admiralty large. Dry coals are much harder than was the case a week ago, and best qualities are now 30s. to 31s. The scarcity of smalls is even more pronounced than large coals, and the demand from Belgium and Germany is particularly for coking descriptions. Best smalls are freely quoted at 25s. to 26s., and in some instances even higher, and business has actually been done in ordinary cargo smalls at 20s. for supplies for delivery over the remainder of the year. Coke is as firm as ever, and is nominally 80s. for export, while patent fuel cannot be obtained at less than 37s. 6d. to 40s. Anthracite coals show a better tendency, and an increased amount of business has been done for forward shipment, but beans, rubbly culm and duff coals are the firmest sections of this market. The scarcity of duff is very marked.

Latest News from the Provinces.

NORTH OF ENGLAND.

New Shipyard for the Tees.

IT is understood that Swan, Hunter and Wigham Richardson, Limited, intend shortly to launch a shipbuilding enterprise on the south bank of the Tees, at Teesport, north of Grangetown. The undertaking is expected to involve a widening and improving of the Tees in the vicinity, in order to permit of the launching of large sized vessels, and a guarantee that these improvements shall be attended to is stated to have been made by the Tees Conservancy Commission. The land purchased for the project was previously owned by Bolckow, Vaughan and Co., Limited, South Bank, to whose works it is in close proximity.

WALES AND ADJOINING COUNTIES.

Swansea Metal Exchange.

Business has been a trifle quieter since the advance in the minimum price of steel bars and the raising of the minimum for tin-plates to 22s. 6d. I.C. f.o.b. As regards the decision to advance tin-plate bars by 10s. per ton, it is reported that makers are not prepared to quote beyond July 31st, and orders for bars to be delivered before that date have to be placed by March 13th, it being considered likely that a further advance in bars is probable.

American Coals.

It is reported that a contract for a quarter of a million tons of coal for shipment to Germany has been concluded.

Docks Working Hours.

At the adjourned conference at Cardiff on Wednesday on the question of a revision of working hours of trimmers and tippers at South Wales docks, the surprise announcement was made by the shipowners' representatives that they had decided that the question at issue should be referred at once to the Industrial Court, expressly on the point as to whether a third shift was justified or not, without any mention of extra remuneration to the workmen. As there was an absolute difference of opinion between the employers' and workmen's representatives, Sir David Shackleton, representing the Ministry of Labour, said the matter would have to be further considered by the Ministry, and in all probability the attendance of representatives of both sides would be required in London shortly to discuss the terms of reference to the Industrial Court.

CONTRACTS.

THE TURBINE FURNACE COMPANY, Limited, informs us that during the last two months it has received orders for its patented turbine furnace with durable fire-bars from twenty-three separate sources at home and abroad, including manufacturing firms, collieries, cement works, gas and waterworks, mills, a mint, a laundry, &c.

THE ENGLISH ELECTRIC COMPANY informs us that it has recently obtained an order for a reversing electrical drive for a 30in. finishing rail mill at Guest, Keen and Nettlefold's Dowlais Works. The mill motor is to be capable of giving a maximum power of 8600 horse-power at a speed of 60 to 120 revolutions per minute.

SIR W. G. ARMSTRONG, WHITWORTH AND CO., Limited, have secured orders during the last few days for thirty-seven heavy main line locomotives, twenty of them being for the Indian State Railways and seventeen for the East Indian Railway. These locomotives, which are intended for goods traffic, are of the 0-6-0 superheated type with six-wheeled tenders for a gauge of 5ft. 6in.

Current Prices for Metals and Fuels.

IRON ORE.

N. W. COAST—	
Native	22/6
(1) Spanish	23/-
(1) N. African	23/-
N.E. COAST—	
Native	—
Foreign (c.i.f.)	25/- to 26/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	6 0 0	—
No. 1 Foundry	6 0 0	—
No. 3 Foundry	5 15 0	—
N.E. COAST—		
Hematite Mixed Nos.	5 15 0	5 15 0
No. 1	5 16 0	5 16 0
Cleveland—		
No. 1	6 10 0	6 10 0
Silicious Iron	6 5 0	6 5 0
No. 3 G.M.B.	6 5 0	6 5 0
No. 4 Foundry	6 0 0	6 0 0
No. 4 Forge	5 15 0	5 15 0
Mottled	—	—
White	—	—
MIDLANDS—		
(3) Staffs.—		
All-mine (Cold Blast)	13 0 0	—
North Staffs. Forge	5 2 6	—
,, ,, Foundry	5 5 0	—
(3) Northampton—		
Foundry No. 3 *		—
,, Forge *		—
(3) Derbyshire—		
No. 3 Foundry	5 0 0 to 5 5 0	
Forge	4 15 0 to 4 17 0	
(3) Lincolnshire—		
Basic	6 0 0 to 6 10 0	
Foundry	4 17 6 to 5 2 6	
Forge	4 15 0 to 5 0 0	
(4) N.W. COAST—		
N. Lancs. and Cum.		
Hematite Mixed Nos.	6 10 0	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	12 0 0	—
Best ,,	—	—
N.E. COAST—		
Crown Bars	12 0 0	—
Tees	10 0 0	—
LANCS.—		
Crown Bars	12 0 0	—
Second Quality Bars	11 5 0	—
Hoops	15 0 0	14 15 0
S. YORKS.—		
Crown Bars	12 10 0	—
Best ,,	13 10 0	—
Hoops	15 10 0	—
MIDLANDS—		
Crown Bars	11 10 0 to 12 0 0	
Marked Bars (Staffs.)	13 10 0	—
Nut and Bolt Bars	10 15 0 to 11 0 0	
Gas Tube Strip	11 15 0 to 12 0 0	—

STEEL

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	13 0 0	—
Ship Plates ⅜in. and up	9 15 0	-
Sections	9 5 0	—
Steel Sheets ¼in. to ½in.	12 0 0	—
Sheets (Gal. Cor. 24 B.G.)	—	19 10 0

STEEL (continued)

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	10 0 0	—
Angles	9 10 0	—
Boiler Plates	14 0 0	—
Joists	9 10 0	—
Heavy Rails	9 10 0	—
Fish-plates	13 10 0	—
Channels	9 5 0	—
Hard Billets	10 5 0	—
Soft Billets	9 10 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	9 10 0	—
Light ,,	11 0 0	—
Billets	10 0 0	—
MANCHESTER—		
Bars (Round)	9 0 0 to 9 10 0	
,, (others)	9 10 0 to 10 0 0	
Hoops (Best)	14 15 0	14 10 0
,, (Soft Steel)	12 15 0	12 10 0
Plates	9 0 0 to 10 0	
,, (Lancs. Boiler)	13 10 0	—
SHEFFIELD—		
Siemens Acid Billets	12 0 0	—
Bessemer Billets	12 10 0	—
Hard Basic	10 5 0	—
Intermediate Basic	10 0 0	—
Soft Basic	9 10 0	—
Hoops	12 15 0 to 13 5 0	
Soft Wire Rods	11 10 0	—
MIDLANDS—		
Small Rolled Bars	10 15 0 to 11 0 0	
Billets and Sheet-bars	9 0 0 to 9 10 0	
Gas Tube Strip	10 15 0	—
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets (f.o.b. L'pool)	19 0 0 to 19 10 0	
Angles	10 0 0	—
Joists	10 0 0	—
Tees	11 0 0	—
Bridge and Tank Plates	10 10 0	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	22/6 to 23/-
Block Tin (cash)	211 15 0
,, (three months)	215 15 0
Copper (cash)	72 12 6
,, (three months)	73 7 6
Spanish Lead (cash)	29 12 6
,, (three months)	29 5 0
Spelter (cash)	36 12 6
,, (three months)	37 0 0
MANCHESTER—	
Copper, Best Selected Ingots	77 0 0
,, Electrolytic	81 0 0
,, Strong Sheets	104 0 0
,, Loco Tubes	0 1 2½
Brass Loco Tubes	0 1 0¾
,, Condenser	0 1 2¾
Lead, English	30 15 0
,, Foreign	29 15 0

FERRO ALLOYS.

(All prices now nominal.)

	Per Ton.	Per Unit
Tungsten Metal Powder	1/11 per lb.	
Ferro Tungsten	1/5 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23	10/6
,, 6 p.c. to 8 p.c. ,,	£21 0 0	8/-
,, 8 p.c. to 10 p.c. ,,	£20 0 0	8/-
,, Specially Refined		
,, Max. 2 p.c. carbon	£52 0 0	20/-
,, ,, 1 p.c. ,,	£62 0 0	22/6
,, ,, 0·75 p.c. carbon	£72 0 0	25/-
,, carbon free	1.6 per lb.	
Metallic Chromium	4/6 per lb.	
Ferro Manganese (per ton)	£16 for home.	
,, Silicon, 45 p.c. to 50 p.c.	£12 0 0 scale 5/- per unit	
,, ,, 75 p.c.	£20 0 0 scale 6/- per unit	
,, Vanadium	17/- per lb.	
,, Molybdenum	9/- per lb.	
,, Titanium (carbon free)	1/1 per lb.	
Nickel (per ton)	£130	
Cobalt	12/- per lb.	
Aluminium (per ton)	£82 to £100 (British Official.)	

FUELS.

SCOTLAND.

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	27.6
,, ,, Ell	28.6
,, ,, Splint	31/6 to 35/-
,, ,, Trebles	30/6
,, ,, Doubles	30/-
,, ,, Singles	30/-
AYRSHIRE—	
(f.o.b. Ports)—Steam	27.6
,, ,, Splint	31.6
,, ,, Trebles	30/-
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	30/- to 32/6
Screened Navigation	35/-
Trebles	31/-
Doubles	30/-
Singles	30/-
LOTHIANS—	
(f.o.b. Leith)—Best Steam	30/-
Secondary Steam	29/-
Trebles	30 6
Doubles	30/-
Singles	30/-

ENGLAND.

(8) N.W. COAST—	
Steams	30/6
Household	46/8 to 57/6
Coke	42.6
NORTHUMBERLAND—	
Best Steams	32/6 to 35/-
Second Steams	27 6 to 30/-
Steam Smalls	20/- to 25/-
Unscreened	20/6
Household	25/- to 28/-
DURHAM—	
Best Gas	33/- to 35/-
Second	30/-
Household	25/- to 28/-
Foundry Coke	70/- to 80/-

SHEFFIELD—	INLAND.	
Best Hand-picked Branch	32/6 to 34/6	—
Barnsley Best Silkstone	28/- to 30/-	—
Derbyshire Best Brights	25/6 to 27/6	—
,, ,, House	23/- to 24/6	—
,, ,, Large Nuts	21/6 to 22/6	—
,, ,, Small ,,	15/- to 16/6	—
Yorkshire Hards	21/- to 22/-	—
Derbyshire ,,	20/- to 21/-	—
Rough Slacks	10/- to 12/-	—
Nutty ,,	8/- to 10/-	—
Smalls	3/- to 7/-	—
Blast Furnace Coke (inland and Export)	24/- to 30/-	

(9) SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Smokeless Large	33/- to 35/-
Second ,, ,,	32/- to 33/-
Best Dry Large	30/- to 32/-
Ordinary Dry Large	29/- to 33/-
Best Black Vein Large	32/6 to 33/6
Western Valley ,,	31/6 to 32/6
Best Eastern Valley Large	31/6 to 32/6
Ordinary ,, ,,	30/- to 31/-
Best Steam Smalls	25/- to 26/-
Ordinary ,,	24/- to 25/-
Washed Nuts	30/- to 32/6
No. 3 Rhondda Large	32 6 to 33.6
,, ,, Smalls	26/- to 27/-
No. 2 ,, Large	27/6 to 30/-
,, ,, Through	25/- to 27/-
,, ,, Smalls	21/- to 23/-
Coke (export)	70/- to 80/-
Patent Fuel	37/6 to 40/-
Pitwood (ex ship)	31/6 to 32/-
SWANSEA—	
Anthracite Coals:	
Best Big Vein Large	35/- to 40/-
Seconds	30/- to 35/-
Red Vein	27/6 to 28/6
Machine-made Cobbles	40/- to 45/-
Nuts	45/- to 47/6
Beans	45/ to 47/6
Peas	20/- to 22/-
Breaker Duff	11/- to 12/-
Rubbly Culm	14/6 to 15/-
Steam Coals:	
Large	27/- to 28/-
Seconds	24/- to 26/-
Smalls	16/- to 19/-
Cargo Through	20/- to 23/-

(1) Delivered. (2) Net Makers' works. (3) At furnaces. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—F.O.B. Glasgow.

(8) Except where otherwise indicated coals are per ton at pit for inland and f.o.b. for export and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b.

* Quotations extremely high and nominal.

French Engineering Notes.

(From our Correspondent in Paris.)

Raw Material.

THE supply of coke is the dominant factor in the iron, steel and engineering trades, and as the quantity available is rapidly diminishing, the prices of raw material are increasing to an extent that is causing serious uneasiness for the immediate future. A few trainloads of coke have been dispatched from the Ruhr, but, as much of it goes to allied and neutral countries, the proportion sent to this country can hardly be regarded as having any effect upon the situation. Efforts are being made to procure coke from Czecho-Slovakia and even from the United States at prices ranging from 250f. to 280f. per ton. The Coke Syndicate is supplying up to 20 per cent. of the minimum quantity required by its members at 198f. per ton, while the coke ovens in the Nord have limited supplies for their regular customers at 135f. per ton. The result is a bewildering discrepancy in the prices of raw iron, and in view of the rapidly diminishing supplies of pig, due to the damping down of furnaces, it is difficult to get prices at all. For some time past negotiations have been carried out between France and Belgium whereby the latter country was to supply a certain quantity of coke in return for scrap; but it has been so far impossible to come to an understanding over the amount of scrap to be sent into Belgium. Owing to the high cost of coke and the heavy diminution of pig production, there has been a withdrawal of stocks of rolled iron and steel, and the difficulty of procuring material except at very high prices is paralysing the metallurgical trades. During the week representatives of the iron, steel and engineering industries have interviewed the Prime Minister in order to see what measures can be taken to relieve the situation, but it is obvious that nothing can be done until the Ruhr has become so far re-organised as to enable the French to ensure a normal production of coke which will be available for the French blast-furnaces.

Cancelling Contracts.

Meanwhile, a vigorous controversy is being carried on between mill and forge owners and their customers over the cancelling of contracts. As soon as the coke situation became so precarious, producers not only found that they would be losing heavily by the execution of old contracts, but that, being unable to procure sufficient quantities of raw iron, they were not in a position to carry out the contracts at all. Now that basic pigs have gone up to 470f. a ton and hematites to 556f. a ton, and that only small supplies are available even at those figures, mill and forge owners have informed customers that all old contracts are cancelled. Consumers are not disposed to accept this situation. They argue that there can be no case of material impossibility when coke can be obtained from abroad by paying the price, and if producers' costs have enormously increased as the result of the practical cessation of coke supplies from the Ruhr there is no reason why they should fail to carry out their engagements towards customers. The legal aspect of the question will probably be fought out, but this does not help to alleviate the situation of engineering and other firms which have to pay very high prices for the limited quantities of rolled iron and steel being doled out to them. As for merchants, they are holding back stocks as much as possible in view of still higher prices.

Colonial Works.

By creating a popular interest in colonial development it is hoped to facilitate loans for the carrying out of public works in the Colonies, for without such loans it would be almost impossible at the present moment to undertake the considerable railway construction, port extensions, &c., which are necessary to develop the resources of the African possessions. The Cameroons have been authorised to raise such a loan for the extension of the railway from its present terminus to Duala, and the port of Duala is to be dredged and provided with additional wharves and warehouses. The railway constructions will cost about 36 million francs. Funds have also been raised by public loans for the carrying out of works in Madagascar, and it is hoped that the necessary money will be procured in the same way for the railway, port, and irrigation works in the West African Colonies, which promise to offer a wide scope for engineering enterprise for many years to come.

Paris Traffic.

Since the motor omnibus and tramway services of Paris were taken over by the Department of the Seine, which constituted a company known as the Transport en Commun de la Région Parisienne, a programme has been carried out aiming at a higher efficiency in the services and a stricter economy in working costs. The results have been a steady improvement in receipts and a reduction in the cost per car-kilometre, and it appears quite possible that, in the early future, this huge motor omnibus and tramway undertaking will be, for the first time, paying its way. During the last three months of 1922 the company carried 239,969,128 passengers, and the total receipts amounted to 76,633,649f. On the busiest lines the average receipts for motor omnibuses ranged from 2.163f. to 3.025f. per kilometre. The suburban tramways gave the least satisfactory results with 1.225f. per car-kilometre. Within three months there will be fifty six-wheeled omnibuses of large capacity on the Madeleine-Bastille line, and motor omnibuses are also to be employed in the suburbs, for which purpose a specially light and fast type for twenty-three passengers will be put into service. At the same time it is to be remarked that the Metropolitan Railway is continually extending, and that further plans have been approved of providing for the construction of a number of new lines which will cover Paris in every direction and will eventually extend to the suburbs. There is an impression that, when the new plans for the Metropolitan and the Nord-Sud have been carried out, the motor omnibuses and tramways will have had their day; but, as a matter of fact, experience has always shown that transport facilities create traffic, and it hardly seems conceivable that the facilities can be in excess of the needs of Paris and the suburbs.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

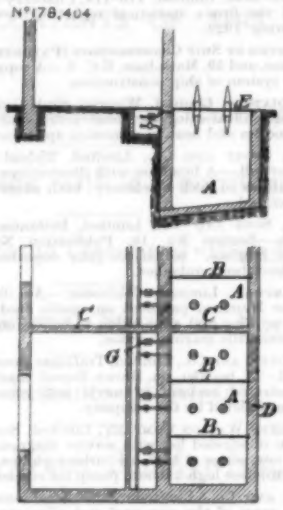
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

SWITCHGEAR.

178,404. August 24th, 1921.—AN IMPROVED HIGH-VOLTAGE SWITCH PLANT, Aktiengesellschaft Brown, Boveri & Cie., of Baden, Switzerland.

ACCORDING to this invention high-tension devices, such as switches, are sunk in the ground and immersed in oil, the container for the oil being built up of masonry. In the drawing A are the oil pits. B are thin partitions, for instance, of metal.

N°178,404

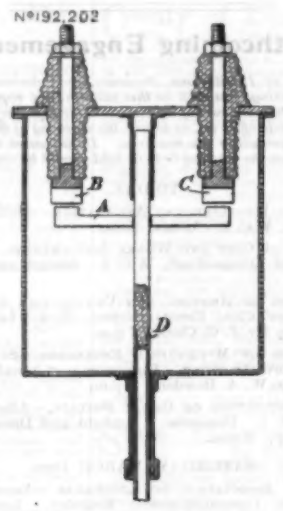


The separating walls C may in some circumstances be constructed like the partitions B. D are the outside walls, which are made comparatively thicker in order to withstand the pressure of the soil. The several pits A are closed by lids E. In order to deal with possible explosions within the pits it is advisable to provide relief valves G.—*January 24th*, 1923.

192,202. November 8th, 1921.—IMPROVEMENTS IN AND RELATING TO ELECTRIC SWITCHES, *The British Thomson-Houston Company, Limited*, 83, *Cannon-street, London, E.C.* 4.

When the switch is opened by lowering the bridge member A the pressure created by the arcs formed between the ends of

N°192,202



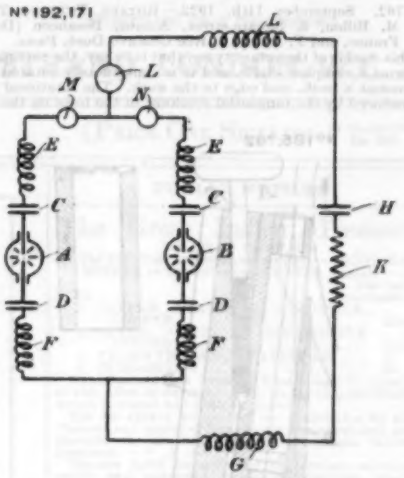
the bridging member and the contacts B and C acts upon the top of the rod D and thus assists in forcing the contacts apart.—*February 1st*, 1923.

TELEGRAPHS AND TELEPHONES.

192,171. October 28th, 1921.—IMPROVEMENTS IN ARC GENERATORS OF ELECTRIC OSCILLATIONS, Henry Melville Dowsett, of 5, Victoria-road, Colchester.

It has been proposed when employing two arcs in parallel for the generation of electric oscillations to insert between the like electrodes of the two arcs two condensers and to connect the output circuit between the two condensers of each pair. In such arrangements these inter-arc condensers have always been of smaller capacity than the condenser of the output circuit. According to this invention each of the inter-arc condensers has a large capacity as compared with that of the condenser in the output circuit, and an inductance coil is also inserted between each condenser and the point of junction of the output circuit with the inter-arc connections, each branch of the arc circuit being electrically equivalent to the other. With this arrangement the inter-arc current can be considerably reduced and the proportion of the total energy which the output circuit can take up is increased. The invention is illustrated in the accompanying drawing, which shows two arcs A and B, the electrodes of which are joined together by condensers C D, and inductance coils E F, which, together, form the inter-arc circuit. The output or aerial circuit to which it is joined is represented by inductance coils G, condenser H and resistance K. Each of the condensers C and D is of large capacity, say, of the order of 1 microfarad. The condenser H is of very much smaller capacity, having a value such as is usual in any standard transmitting aerial. The inductances of the coils E and F are sufficiently large, compared with the inductances of the coils G, to cause the current through the output circuit as indicated at L to be almost equal to the sum of

N°192,171

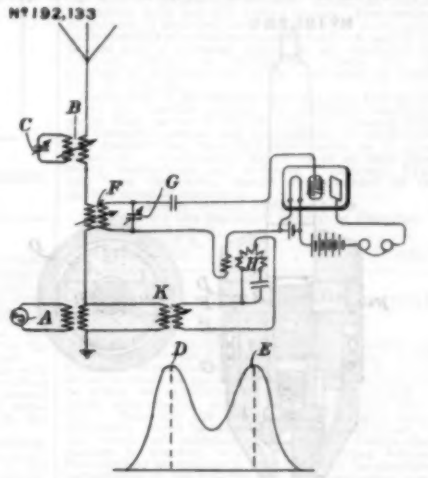


the currents as indicated at M and N, so that the component of the current in the inter-arc circuit which flows into the aerial may be as large as possible. The relative positions in each branch of the inter-arc circuit of the condensers and the inductance coils may be reversed if considered desirable without affecting the principle of working.—*January 20th*, 1923.

192,133. October 20th, 1921.—IMPROVEMENTS IN AND RELATING TO RADIO SIGNALLING SYSTEMS, *The British Thomson-Houston Company, Limited*, 83, *Cannon-street, London, E.C.* 4.

The object of this invention is to provide a means for making an antenna which is used for the simultaneous reception and transmission of signals resonant to two different frequencies at the same time. The source of current is shown at A. A closed oscillating circuit made up of an inductance B and capacity C is coupled to the antenna by means of a coupling transformer as shown, and this circuit is adjusted and coupled to the antenna in such a way that the latter will be resonant to two different frequencies. The tuning curve of the antenna is shown below the diagram of connections. The antenna is tuned so that one

N°192,133



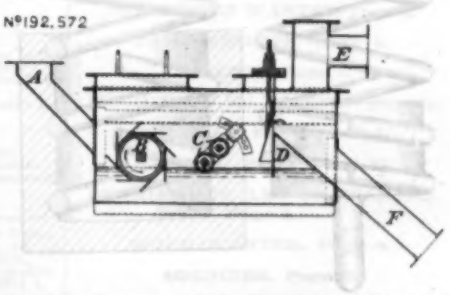
of the points—say, for example, the point D—represents the frequency of the source, whilst the point E represents the frequency of the signals to be received. The receiving circuit, which is made up of the inductance F and capacity G, is coupled to the antenna by means of a coupling transformer in the usual manner. At H there is a phase rotator, the secondary of which is connected to the receiving circuit as shown, and by this means a potential may be impressed on the receiving circuit of the opposite phase to that impressed by the antenna, and the amplitude of this potential may be adjusted by means of the coupling transformer K so as to neutralise the potential in the receiving circuit from the source A. The effect of the local source A upon the receiving circuit may therefore be neutralised.—*January 22nd*, 1923.

METALLURGY.

192,572. January 4th, 1922.—DISTILLING WOOD REFUSE, The Thermal Industrial and Chemical Research Company, Limited, and J. S. Morgan, 52, Grosvenor-gardens, London, S.W. 1.

Wood chips are fed into the apparatus through the shoot A and are caught by the paddle B, which presses them down

N°192,572



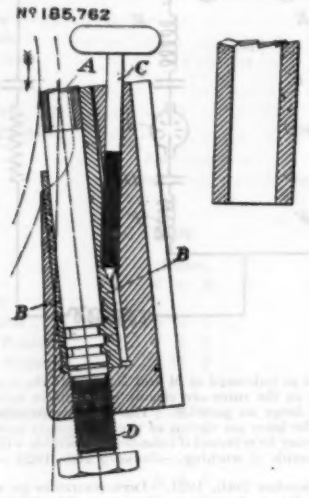
through a bath of molten lead. They float up again and are crushed as they pass between the rolls C C. The charred material goes on to the right and is blown through the adjustable open-

ing D by the pressure of the gases evolved during distillation. The gases escape at E and the charred material at F.—*February 8th*, 1923.

MACHINE TOOLS AND SHOP APPLIANCES.

185,762. September 11th, 1922.—ROTARY TURNING TOOLS, M. Billon, 2, Square-street, Amour, Besancon (Doubs), France, and F. Dufay, 8, Rue Gustave Doré, Paris.

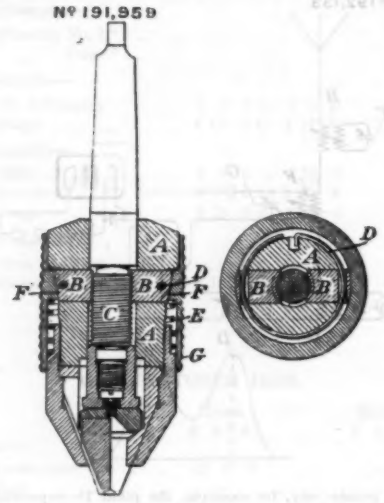
This tool is of the rotary type; that is to say, the cutting edge A forms a complete circle, and it is continuously rotated so as to present a fresh, cool edge to the work. The rotational effect is produced by the tangential resultant of the force on the edge,



which is formed somewhat like a rose cutter, as shown in the detail sketch. The inventor states that the tangential force is so great that it is necessary to provide a braking effect by pinching the two halves B B of the bearing together by means of the screw C. The height of the cutter is adjusted by means of the screw D.—*January 4th*, 1923.

191,959. January 13th, 1922.—CHUCKS, Sir A. Herbert, Dunley Manor, Whitchurch, Hampshire, and A. H. Lloyd, 33, Styvechale-avenue, Earlsdon, Coventry.

In this drill chuck the jaws can be opened or closed while the spindle is rotating. The body A is a sliding fit on the spindle and carries two pads B B that together form a split nut. These pads are pushed out of engagement with the screw C by the spring D.

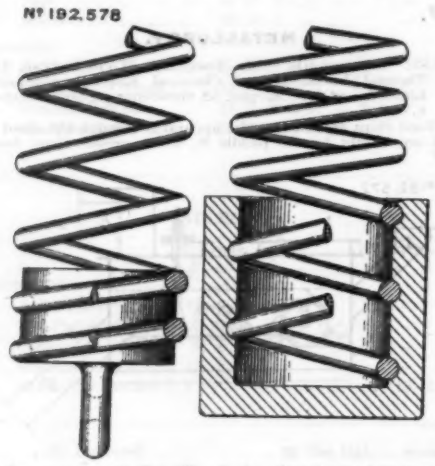


On the other hand, however, they are engaged with the screw by the stronger spring E acting through the sloping faces F F of the outer sleeve G. If the sleeve G is pushed downward by hand the jaws are released and the drill can be removed. If it is pushed upward the pads come into engagement with the screw and the jaws are tightened.—*January 25th*, 1923.

MISCELLANEOUS.

192,578. January 9th, 1922.—SECURING THE ENDS OF HELICAL SPRINGS, C. H. Gale, St. John's, Bishopstoke, Hants.

The inventor proposes to make attachments to the ends of



helical springs without it being necessary to soften them, by means of plugs or sockets having grooves of a different pitch from the turns of the spring. In the case of tension springs the groove is of a lesser pitch, while for compression springs the groove pitch is the greater. The drawings are self-explanatory.—*February 8th*, 1923.

Catalogues.

STAVELEY COAL AND IRON COMPANY, Limited, Chesterfield.—Monthly stock list of cast iron pipes.

GEO. ANDERSON, 9, Fenchurch-street, E.C. 3.—An illustrated list of dredgers and plant now available for disposal.

BROOM AND WADE, Limited, High Wycombe.—An illustrated descriptive catalogue on air compressors and vacuum pumps.

FARRAR BOILERWORKS, Limited, Newark-on-Trent.—An illustrated list of boilers and accessories manufactured by the company.

MADA ENGINEERING COMPANY, Limited, 17, Bevington-hill, Liverpool.—An illustrated catalogue describing the "Remca" electric riveter.

HENRY BERRY AND CO., Limited, Croydon Works, Leeds.—A copy of new pamphlet on boiler works plant, which illustrates the machines required.

JORDAN AND SONS, Limited, 116–118, Chancery-lane, W.C. 2.—A copy of the firm's statistical report of new companies registered during 1922.

MILLAR SYSTEM OF SHIP CONSTRUCTION (PATENTED), Limited, 1, Seething-lane, and 59, Mark-lane, E.C. 3.—A copy of a booklet on the Millar system of ship construction.

SERCK RADIATORS, Limited, Warwick-road, Greet, Birmingham.—Catalogue illustrating the construction and various uses of Serck oil coolers and heat transmission apparatus.

CHAMBERS, SCOTT AND CO., Limited, Dalziel Engineering Works, Motherwell.—A brochure with illustrations of the firm's marine specialities in deck machinery, both electrically, steam and hand operated.

MARSHALL, SONS AND CO., Limited, Britannia Ironworks, Gainsborough.—Section No. 10, Publication No. 1316, on "Drop Valve Engines," which are fully described, and many illustrations have been embodied.

A. G. MUMFORD, Limited, Colchester.—An illustrated list describing the Mumford patented automatic feed water regulator and its working and application to boilers on land and in naval and mercantile marine service.

BROWN, BOVERI AND CO., Limited, Trafalgar House, Waterloo-place, S.W. 1.—A booklet on Brown-Boveri marine turbines, with an illustrated account of naval and commercial ship installations completed by the company.

THE MIRRLEES WATSON COMPANY, Limited, Scotland-street, Glasgow.—An illustrated list with service diagrams descriptive of the firm's new series of high-lift turbine pumps, and a pamphlet on the Mirrlees high vacuum pump for condensers.

J. BROWN AND CO., Limited, Atlas Steel and Ironworks, Sheffield.—A copy of the new tool and alloy steel catalogue. A great deal of useful information has been collected and embodied in this book. Several pictures in colour are reproduced.

THE NORTH-EASTERN MARINE ENGINEERING COMPANY, Limited, Wallsend-on-Tyne.—An illustrated catalogue of North-Eastern Werkspoor marine Diesel oil engines. A descriptive leaflet of a new patented balanced stop valve and manœuvring valve.

THE MITCHELL LIBRARY, Glasgow.—A classified list of books in the libraries of Glasgow, which is one of the joint technical catalogues issued by the Committee. This section deals with motor vehicles. Copies may be obtained from John Horn, Limited, 149, Howard-street, Glasgow.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

EX-BRITISH-WESTINGHOUSE ASSOCIATION.—Holborn Restaurant, London, W.C. 1. Annual dinner.

INSTITUTE OF COST AND WORKS ACCOUNTANTS.—Connaught Rooms, Great Queen-street, W.C. 2. Second annual costing conference.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS.—The Engineers' Club, Coventry-street, W. 1. Lecture, "Gas as a Fuel," by Mr. J. G. Clark. 7 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's Gate, S.W. 1. Informal meeting. Discussion:—"Aerial Ropeways," opened by Mr. W. A. Bowden. 7 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. 1. Discourse, "Sunlight and Disease," by Dr. C. W. Saleeby. 9 p.m.

SATURDAY, MARCH 10TH.

KEIGHLEY ASSOCIATION OF ENGINEERS.—Assembly Room, Cycling Club, Cavendish-street, Keighley. Lecture, "The Relations of Iron with Carbon, Silicon and Phosphorus," by Mr. F. C. A. Lanteberry. 6.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. 1. "Atomic Projectiles and their Properties" (IV.), by Sir Ernest Rutherford. 3 p.m.

MONDAY, MARCH 12TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—The College, Loughborough. Loughborough Graduates' meeting. Paper, "The Process of Ignition," by Mr. A. P. Young. 7 p.m.

NORTHAMPTON ENGINEERING COLLEGE ENGINEERING SOCIETY.—St. John-street, E.C. 1. General meeting. 5.30 p.m.

MONDAY AND TUESDAY, MARCH 12TH AND 13TH.

INSTITUTION OF CIVIL ENGINEERS: NEWCASTLE-UPON-TYNE ASSOCIATION.—Neville Hall, Newcastle-upon-Tyne. Vernon Harcourt Lectures on "Foundation in Dock and Harbour Works," by Mr. T. R. Wilton. 7.30 p.m.

TUESDAY, MARCH 13TH.

INSTITUTE OF MARINE ENGINEERS.—85/88, The Minories, Tower Hill, E. 1. "The Development of the Air Pump for High Vacuum," by Mr. W. A. Dexter. 6.30 p.m.

INSTITUTE OF METALS: BIRMINGHAM LOCAL SECTION.—Chamber of Commerce, New-street, Birmingham. Paper, "Casting Temperature Conditions and the Properties of Phosphoric Bronze," by Mr. G. L. Bailey. 7 p.m.

INSTITUTE OF METALS: NORTH-EAST COAST LOCAL SECTION.—Armstrong College, Newcastle-on-Tyne. Paper, "The Corrosion of Metals," by Dr. W. H. Hatfield. 7.30 p.m.

INSTITUTE OF METALS: SCOTTISH LOCAL SECTION.—Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. Annual general meeting. Discussion, "Problems Awaiting Solution," opened by Professor J. H. Andrew. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS: COVENTRY CENTRE.—Railway Hotel, Coventry. Informal meeting. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Visit of the London Graduates to the works of Leyland Motors, Limited Kingston-on-Thames. Meet outside the works, 3 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, S.W. 1. Continued discussion on "Some Problems Connected with the Rivers and Canals in Southern India," by Mr. J. M. Lacey; "An Irrigation Project of the Californias," by Mr. S. L. Rothery; "The Influence of Silt on the Velocity of Water Flowing in Open Channels," by Mr. A. B. Buckley, jun. 6 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE.—The North British Station Hotel, Edinburgh. Paper, "The Maintenance of Voltage on a Direct-current Distribution System by Means of a Fully Automatic Sub-station," by Mr. P. J. Robinson. 7 p.m.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.—Royal Society of Arts, John-street, Adelphi, W.C. 2. Presidential address by Professor J. S. S. Brame. 5.30 p.m.

MANCHESTER GEOLOGICAL AND MINING SOCIETY.—Queen's Chambers, 5, John Dalton-street, Manchester. Paper, "Notes on an Experiment on Hydraulic Stowing," by Mr. A. J. A. Orchard. 3 p.m.

WEDNESDAY, MARCH 14TH.

ELECTRO-HARMONIC SOCIETY.—The Caxton Hall, Westminster, S.W. 1. Last smoking concert of the season. 8 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Institution of Mechanical Engineers, Storey's-gate, S.W. 1. Paper, "Multi-wheel and Track Motor Vehicles," by Major T. G. Tulloch. 7.45 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, S.W. 1. Students' meeting. Paper, "The Compression System of Refrigeration and Machines Operating thereon," by Mr. F. J. Symonds. 6 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS: LANCASHIRE AND CHESHIRE BRANCH.—Engineering Laboratory, Victoria University, Manchester. Further discussion of Mr. A. S. Spencer's paper, "Flexual Resistance." 7.15 p.m.

UNIVERSITY OF LONDON.—Institution of Electrical Engineers, Savoy-place, Victoria Embankment, W.C. 2. Lecture, "The Control of the Speed and Power Factor of Induction Motors, III.: The Use of Double and Triple Circuits in Series with the Rotor, &c.," by Professor Miles Walker. 5.15 p.m.

THURSDAY, MARCH 15TH.

INSTITUTE OF METALS: LONDON LOCAL SECTION.—Institute of Marine Engineers, 85–88, The Minories, E. 1. Discussion, "The Heat Treatment of Non-ferrous Metals," opened by Mr. W. B. Clarke. 8 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, W.C. 2. Joint meeting with the Royal Institute of British Architects. "Co-operation Between the Architect and the Electrical Engineer," by Messrs. F. Hooper and J. W. Beauchamp. 6 p.m.

FRIDAY, MARCH 16TH.

INSTITUTE OF METALS: SWANSEA LOCAL SECTION.—University College, Singleton Park, Swansea. Paper, "Gaseous Firing of Industrial Furnaces," by Dr. E. W. Smith. 7.15 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's Gate, Westminster. Report of Steam Nozzles Research Committee 6 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—East Midland District meeting at Ashby-de-la-Zouch. 11.15 a.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. "Comparative Power Costs," by Mr. C. H. Woodfield, 7.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. 1. Discourse, "The Novels and Stories of J. Sheridan le Fanu," by Dr. M. R. James. 9 p.m.

SATURDAY, MARCH 17TH.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. 1. Lecture, "Atomic Projectiles and their Properties" (V.), by Sir Ernest Rutherford. 3 p.m.

MONDAY, MARCH 19TH.

INSTITUTION OF AUTOMOBILE ENGINEERS: SCOTTISH CENTRE.—Royal Technical College, Glasgow. "The Principles of Vehicle Suspension," by Mr. H. S. Rowell. 7.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, Westminster, S.W. 1. Graduates' meeting. "The Walschaert Locomotive Valve Gear," by Mr. R. C. Bond. 7 p.m.

TUESDAY, MARCH 20TH.

INSTITUTE OF MARINE ENGINEERS.—85/88, The Minories, Tower Hill, E. 1. "Operation of Marine Oil Engines, Cylinders and Pistons," by Mr. John Lamb. 6.30 p.m.

INSTITUTE OF TRANSPORT.—Institution of Electrical Engineers, Savoy-place, Victoria Embankment, W.C. 2. Graduates' and students' meeting. Lecture, "Town-planning and Re-modelling in relation to Traffic" 5.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: NORTH MIDLAND CENTRE.—Hotel Metropole, King-street, Leeds. "Permissible Loading of British Standard Paper-insulated Electric Cables." British Electrical Research Association's report, presented by Messrs. S. W. Melsom and E. Fawssett. 7 p.m.

NEWCOMEN SOCIETY.—Prince Henry's Room, 17, Fleet-street, E.C. 4. Paper, "The Early History of the Gas Process," by Mr. D. Brownlie. 5.30 p.m.

WEDNESDAY, MARCH 21ST.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Chamber of Commerce, New-street, Birmingham. Graduates' meeting. Debate, "Fixed v. Detachable Cylinder Heads," opened by Messrs. T. G. Bradley and J. T. Buswell. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS: NORTH OF ENGLAND CENTRE.—Y.M.C.A. Hall, Albion-street, Leeds. Paper, "Principles of Vehicle Suspension," by Mr. H. S. Rowell. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS: WOLVERHAMPTON CENTRE.—Star and Garter Hotel, Wolverhampton. Paper, "Gear-boxes for Motor Cycles," by Mr. J. Cohen. 7.30 p.m.

WEDNESDAY TO FRIDAY, MARCH 21ST TO 23RD.

INSTITUTION OF NAVAL ARCHITECTS.—Royal United Service Institution, Whitehall, W.C. 2. Annual meetings.

FRIDAY, MARCH 23RD.

INSTITUTE OF METALS: SHEFFIELD LOCAL SECTION.—Mappin Hall of the University, St. George's-square, Sheffield. Paper, "Further Notes on Britannia Metal," by Captain F. Orme. 7.30 p.m.